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ASSESSMENT OF PELAGIC AND NEARSHORE FISH IN THREE BAYS ON THE EAST AND SOUTH COASTS OF KODIAK ISLAND, ALASKA

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FINAL REPORT

A contribution to biological information needed by OCSEAP/BLM in making decisions with respect to off-shore oil leases. Work performed under proposal number RU485, Tasks A-7, A-8, A-9, and A-11. Contract No. 03-5-022-67, T.O. No. 12

UNIVERSITY OF WASHINGTON
COLLEGE OF FISHERIES
FISHERIES RESEARCH INSTITUTE

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Approved

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Director

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ABSTRACT

As part of the large baseline study of the Alaskan outer continental shelf sponsored by the Bureau of Land Management, this project was a qualitative assessment of the nearshore and pelagic fishes in Ugak, Kaiugnak, and Alitak bays on the east and south coasts of Kodiak Island. Our principal objectives were to determine the species composition of the pelagic and nearshore estuarine fish fauna, the distribution and relative abundance of common species, and age class composition and food habits of principal species. Sampling took place during four cruises from late May to mid-September, 1976, and employed a midwater herring trawl, a surface tow net, a beach seine, a try net, and trammel nets.

Our main finding was the use of the estuarine bays as nursery areas by numerous fish species. Larval fish were caught abundantly despite the mesh sizes of our gear, but mainly juvenile fish were found in the nearshore and pelagic habitats within the bays. Seventy species were found in the study area, but our checklist should not be considered exhaustive. More species were encountered in the subtidal zone than in the intertidal and pelagic habitats. Large numbers of juvenile capelin and young-of-the-year Pacific sandfish were found in the pelagic zone, yet very few adults of these species occurred in the catches. Capelin were especially abundant throughout the study area while the sandfish population decreased toward the "southern end of the island. Diel vertical migrations were evinced for both species. The other major pelagic forms were young-of-the-year and postlarval sand lance, caught only in the early summer, and juvenile salmon, Pink salmon and, in much less abundance, chum salmon moved from the nearshore to pelagic habitats during early summer, and had largely left the bays by the last cruise. Numerous other species represented mainly by juvenile stages were also found in the pelagic zone. Few large fish were caught, perhaps a result of gear selectivity. The nearshore zone especially hosted a diverse community of predominantly juvenile fishes. Greenling, salmonids, pleuronectids, cottids, and sand lance made up most of the catches, but many other species were represented in the nearshore zone as well. Sand lance and, in the first part of the summer, -juvenile pink and chum salmon were the most abundant nearshore residents, but nonschooling species such as greenling, flatfishes, cottids, and blennioids were caught more frequently "albeit in much less abundance. Areas of concentration were found for a number of nearshore species.

The food habits of principal species were determined to identify the important food resources in the estuaries. There was a wide variation in the diets, but generally the nearshore fishes ate large quantities of benthic and epibenthic organisms such as harpacticoids, cumaceans, gammarideans, polychaetes, barnacles, and bivalve and univalve molluscs. Piscivorous fish fed mainly on sand lance, but also on juveniles of many other species. Calanoid copepods were the major prey of most pelagic fishes examined, but crustacean and fish larvae, pelagic eggs, amphipods and euphausiids were also important.

While a baseline assessment does not permit firm conclusions regarding the impacts of industry on an environment, some relevant iriterpretations should be possible. The habitats surveyed in this study are critical in light of potential oil pollution as they are used as spawning and rearing areas by numerous commercial and noncommercial species. The nearshore and epipelagic fishes might be especially susceptible to the inimical effects of oil contamination. Toxic, water soluble fractions of oil would presumably first contaminate the surface waters, important to juvenile salmonids and greenling. Inshore drift of contaminants would pose a threat to spawning capelin, herring, and greenling and to their inshore larval progeny, as well as to homing salmon, juvenile salmon in the late spring and early summer, and to many other populations of juvenile fishes such as flatfishes, sculpins, and sand lance.

ASSESSMENT OF PELAGIC AND NEARSHORE FISH IN THREE BAYS ON THE EAST . AND SOUTH COASTS OF KODIAK ISLAND, ALASKA

INTRODUCTION

This project is one of the many research efforts designed to provide environmental baseline information needed to assess the potential impact of offshore oil exploration and production on the Alaskan outer continental shelf. Before the potential oil resources under the shelf can be explored or exploited, an environmental impact statement must be prepared, as mandated by the National Environmental Policy Act of 1969. The Bureau of Land Management (Department of Interior) was given jurisdiction of the outer continental shelf by the Outer Continental Shelf Lands Act of 1953, and is responsible for producing the impact statement. The BLM enlisted the technical, logistic, and administrative assistance of the National Oceanic and Atmospheric Administration (NOAA), which set up the Outer Continental Shelf Environmental Assessment Program (OCSEAP) office to contract, manage, and coordinate the research projects needed to provide the information for the preliminary and final environmental impact statements.

One of the proposed areas *to* be leased for offshore oil exploration lies on the outer shelf just east of Kodiak Island. The Kodiak lease area has a diverse and abundant flora and fauna, and supports some of the most important domestic and foreign fisheries in the north Pacific. Many commercial and non-commercial species depend on the estuarine nearshore and pelagic habitats along the Kodiak coast for spawning, juvenile rearing, or feeding, and therefore these habitats and their biota have received much attention in the OCSEAP research effort. This project was designed to provide qualitative baseline information on the finfish inhabiting the nearshore and pelagic habitats of three representative bays on the east and south coasts of Kodiak Island. The information will be used by OCSEAP/BLM in making decisions with respect to petroleum resource exploration of the Kodiak lease area.

Our specific goals, pursuant to OCS Task Nos. A-7, A-8, A-9, and A-11, were to determine (1) the species composition of the pelagic and nearshore ichthyofauna of the three bays, (2) relative abundance by species, (3) age composition of the populations of major species by means of length frequency analysis, (4) food habits of abundant or otherwise major species, and (5) seasonal and diel migrations and changes in distribution.

This project is complemented by a similar study of the demersal fishes in the same area "by the Alaska Department of Fish and Game (OCSEAP Research Unit No. 486). The most complete picture of the island's estuarine fish fauna will necessitate review of both studies.

CURRENT STATUS OF KNOWLEDGE

A fair amount of exploratory research has been done on the demersal fauna inhabiting the bays and banks around Kodiak Island, but there is very little published literature on the nearshore and pelagic estuarine fishes of the island.

Rutter's (1898) paper is certainly one of the first accounts of intertidal fishes on Kodiak Island, although most of the effort in that study was on the outer, exposed coast on the west side. His paper is a list and description of several intertidal fishes, primarily cottid species, which he encountered near Karluk and in Uyak and Alitak hays. Very little ichthyological survey work took place in the Gulf of Alaska after the frequent expeditions around the turn of the century. The next comprehensive study of Kodiak intertidal fishes to our knowledge was by Hubbard and Reeder (1965a,b), who examined 71 samples from several bays on the east side of the island. They documented several range extensions and concluded from their results that the intertidal fish fauna of Kodiak Island is more similar to that of northern Washington and British Columbia than to that of the Aleutian chain and the Bering Sea.

To our knowledge, there is no published literature on the subtidal, littoral fishes of Kodiak Island.

The midwater habitat of the island's estuarine bays has not been studied, but the epipelagic zone at least has been sampled repeatedly. Each summer since 1963 FRI personnel have sampled by a surface tow net several large bays on Kodiak and Afognak islands (including the bays surveyed in the present study) to monitor the abundance and distribution of juvenile pink salmon (Tyler; 1972, and unpublished ins.). The intent has been to use juvenile abundance to forecast the size of the adult run one year later. Other fishes were noted in these studies, especially the abundant ones such as juvenile greenling, Pacific sandfish, and capelin. Juvenile greenling were often found in close association with young pink and chum salmon. Gosho studied the food habits of pink and chum salmon and juvenile greenling caught in the 1971 townet sampling of Kiliuda and Alitak bays (Gosho, 1977, and unpublished data).

Considerable information on the timing of salmon runs to the Kodiak-Afognak area has come from aerial stream surveys conducted since 1952 by Fisheries Research Institute personnel (see Bevan, 1950 for earlier information, and annual stream survey reports in FRI Circulars starting with Bevan, 1953). The Karluk sockeye salmon population has been extensively studied through tagging projects and stream surveys. A study by Rich and Morton (1929) showed that most of the sockeye salmon tagged near Uganik Bay were bound for the Karluk River, and that the mean rate of travel in the last leg of the spawning migration was 10 to 15 miles per day. Major tagging experiments in 1948 and 1949 on the sockeye salmon on the west side of Kodiak Island, designed largely to provide estimates of run size, provided information on migratory routes and timing in the immediate Kodiak area (Bevan, 1959). A tagging study of Olga Bay sockeye salmon by Barnaby and DeLacy (Bower, 1940) indicated a one- to two-week lag between when the fish are encountered at the mouth of Moser Bay (northwest corner of Alitak Bay) and their arrival at the stream weirs around Olga Bay.

DESCRIPTION OF THE STUDY AREA

Kodiak Island is a southwestern extension of the Kenai Peninsula and has a mostly mountainous terrain and a "highly dissected, fiord indented, rugged coast" (AEIDC and ISEGR, 1974). There are stretches of sandy shoreline on the southwest coast but most of the shoreline is perhaps best described as a drowned glacial erosion coast (Shepard, 1973) featuring numerous estuarine bays extending deep into the interior. Climatologically, the Kodiak area is mild for its latitude and moist (mean monthly temperatures at Shearwater Bay range from 30.2 F in December to 54.0 F in August, mean annual precipitation is 97.9 in at ShearWater Bay and 54.4 in at Kodiak; data from Environmental Data Service, NOAA). Marine ice forms only locally in bays during periods of exceptionally cold weather (Nybakken, 1969).

The dominant circulatory feature in the area is the Alaska Stream which flows in a south-southwesterly direction at about 25-75 cm/sec at the shelf break 60-80 km off the east coast of the island (AEIDC and ISEGR, 1974). The inshore circulation is poorly known, but is determined mostly by the complex interaction of tidal fluctuations (2.6 m mean diurnal range at Kodiak; National Ocean Survey, 1976) and geomorphology, and any westward drift or suspected eddy from the Alaska Stream.

The Kodiak Island region is very productive biologically, and its many and diverse fisheries make it one of the most important seafood producing areas in the nation. The east and south coasts contribute greatly to the overall production and should be considered especially important in light of the proposed oil lease areas just north, east, and southeast of the island.

We selected Ugak, Kaiugnak (including Kiavak Bay) and Alitak bays to be our study area as they are quite different from each other in size and morphology but together well represent most of the estuarine habitats on the east and south coasts of the island (Fig. 1). Ugak Bay is about 35 km long and gradually narrows to form a very protected and diverticulate head. Most of the shoreline is precipitous or at least steep, with solid rock faces, boulders, rubble, or cobble comprising the intertidal substrate. Beaches that terminate gentler slopes and beaches near river mouths have muddy (only at the head of the bay), sandy, or black gravel substrate. The neritic zone is narrow in most places since the subtidal bottom is submarine mountainside. In a few bights and harbors alluvial deposits have formed fairly wide banks and shelves. The inner region of Ugak Bay attains a depth of about 97 m, and is separated from the outer bay by a narrow sill 33 m deep extending across the bay from Saltery Cove. The outer region of the bay has a maximum depth of 104 m. Kaiugnak Bay is basically similar to Ugak Bay except that it is only 15 km long and hence more exposed to the ocean, and includes two large lagoons. The bottom of Kaiugnak Bay is quite irregular, but has no sill to make the bay a true fjord. The maximum depth is 123 m at the mouth, and the mean depth near the middle of the bay is about 80 m. Alitak Bay is much larger than the other bays, opens on the south side of the island, and has a considerably more complex shoreline and bottom topography. The exposed eastern shore consists of rubble, rocky bluffs and a few sand and gravel bights. The west side of " Alitak is shallow and has many islands, reefs, and small, protected bays. Alitak Bay is only about 46 m deep at the southeast corner of the mouth, and reaches a maximum depth of about 181 m in the long, deep trough forming Deadman Bay. The bottom contour is irregular and features two large reefs near the middle of the bay.

FIELD METHODS

Gear, Sampling Methods and Locations

We sampled the pelagic and nearshore zones of the bays with five types of fishing gear, each considered appropriate for a particular genre of habitat. The pelagic zone was sampled by a midwater herring trawl in the mesopelagic and lower epipelagic zones, and by a tow net in surface waters. A beach seine was used to sample the intertidal zone, and a try net (small otter trawl} and trammel nets were used in the subtidal littoral region. The try net sampled the smooth-bottomed banks and shelves, and the trammel nets were set off rocky bluffs, amidst boulders, and in kelp beds to sample habitats unworkable by active gear. 'Detailed descriptions of these gear follow.

1) The tow net was 14.9 m long, 6.1 m wide and 3.1 m deep at the mouth, and made from green nylon. The stretch mesh sizes were 7.6 cm at the mouth, 3.8 cm and 1.9 cm in the body, and 0.64 cm in the last 5.6 m of the net. The codend had a zipper for opening and closing, and the foot rope and head rope had leads and floats, respectively, to ensure proper opening of the net. The net was attached to two vertical steel poles, and a 6.8 kg weight and a large float were attached to each pole near the foot rope and head rope connections, respectively. Towing bridles were 9.2 m long. This net is designed to be towed between and behind two boats to avoid propeller wash.

2) The Marinovitch herring trawl was 27.5 m long, 6 m wide and 5 m deep at the mouth, and made from black nylon. The stretch mesh sizes were 7.6 cm in the wings, 6.4 cm in the throat, 5.1 cm and 3.8 cm in the body, and 1.3 cm in the codend. The 1.53 x 2.,14 m steel V-doors were attached to the trawl via 55 m steel cable bridles. A standard warp formula of 2.25 times desired depth + 7.3 m was used.

3) The beach seine was 47.3 m long by 3.05 m deep at the ends, and by 4.4 m deep at the middle. Stretch mesh sizes graduated from 3.2 cm in the outer 14.9 m panels, to 1.0 cm, and finally to 0.3 cm in the innermost partial bag, 3.9 m wide. Sufficient floats and 56.2 gm leads were present to keep the net on the bottom and the float line from sagging below the surface. Netting was white knotted nylon in the outside mesh and green knotless nylon in the inner three panels.

4) The try net was 6.1 m long, 3.3 m wide and 0.76 m deep at the mouth, and made from green knotted and knotless nylon. Stretch mesh sizes were 3.8 cm in the throat and body, 2.9 cm in the 1.8 m long codend, and 0.64 cm in the codend liner. Four 12.7 cm diameter floats and a tickler chain were affixed to the head and foot ropes, respectively, in turn attached directly to the 0.61 x 0.33 m steel and wooden otter doors. A 7 m bridle connected. the doors to

a swivel at the end of the towing cable, and a 6.8 kg lead ball was attached near the swivel to help keep the net on the bottom. A standard warp formula of 4 times desired depth + 7.3 m was used.

5) Each trammel net was 45.7 x 1.8 m with 51 cm stretch mesh in the two outer panels and 5 cm mesh in the loosely hanging inner panel. Material was green knotted nylon. The lead line was 1.27 cm diameter leadcore rope, and four floats were evenly spaced along the polypropylene float line. The two nets were shackled together in an L-shape, with one end tied to shore, a 7.3 kg anchor at the right angle, and a small Danforth anchor at the outer end.

Field sampling took place during four cruises. The first cruise (May 21 - June 3, 1976) was on the R/V Commando, a 20.4 m fisheries research vessel maintained by the College of Fisheries, University of Washington. The Commando is equipped with radar, loran, and a Simrad EH2 echosounder which was used during trawling. The beach seine and midwater trawl were the only types of gear available in the first cruise. The second cruise (June 16 - June 30) was on the 12.8 m commercial purse seiner M/V Dutch Girl, also equipped with radar and a Simrad echosounder. All gear types were used during the second cruise except the midwater trawl, which could not be set from the seiner. All five gear were employed in the last two cruises (July 15 - August 7 and August 25 - September 16), again on the R/V Commando.

Midwater trawl hauls were usually ten minutes in duration, and were about 1.3 km long. In the first cruise the midwater trawl was fished also on the surface since the tow net was not available. Trawling transects and stations were selected to represent all major morphological features of the bays (arms, bights, troughs, etc.). Additional sets were made in cruise 1 when the echosounder indicated large or numerous traces. Trawling depths were in 9 or 18 m increments, and were decided largely in advance. A slight modification toward proportional sampling seemed warranted on the basis of early catches and echosounding information, which indicated more fish in the deeper strata (within about 30 m from the bottom). All cruise 1 stations except one were repeated and a few more were added in subsequent cruises. The original trawl depths of cruise 1 were generally repeated in cruises 3 and 4, although in both later cruises a few stations were sampled randomly with respect to depth. Midwater trawling was done in all daylight hours, and four nighttime sets were made in Ugak Bay during the third cruise.

We townetted in cruises 2-4 by towing the net on the surface between the large boat and an outboard skiff or a diesel-powered purse seine skiff. At the end of a ten minute tow, covering about 0.74 km, the entire net was hoisted on board the large boat for emptying. To allow valid comparison of our results with past FRI tow net data from these bays, we duplicated past methods closely. This included using many of the transects and stations of past projects, and sampling at night in Ugak and Kaiugnak bays and in day in Alitak Bay. In the fourth cruise (early September) a few experimental nighttime tows were made around Cape Hepburn in Alitak Bay as well.

The try net was towed from the Dutch Girl in cruise 2 and from the diesel-powered seine skiff with help from a Model 8274 12-v Warn winch in the last two cruises. Try net sites were selected in cruise 2 on the basis of smooth and workable substrate, habitat type, and location in the bays. Trawl depths of 4, 9, and 13 m were maintained by an echosounder or sounding line. Tows were ten minutes long and covered about 0.46 km depending on the force and direction of wind and current. Try net sampling was diurnal.

The trammel nets and beach seine were set from a 4.6 m Delta Marine fiberglass skiff. The trammel nets were set off rocky bluffs and/or in kelp beds, usually near beach seine and try net sites. The two trammel nets were always set together, one attached to and perpendicular to shore, and the other attached to the first but parallel to shore. Sets were 10, 5, and 2.5 hrs long in cruise 2, and almost always 2.5 hrs long in subsequent cruises since the shorter sets produced adequate samples. Trammel net sets were mostly diurnal. The beach seine was set by anchoring one end to shore and laying the net out from the skiff to form a semicircle. As the arc was closed, the seine was manually pulled to shore. Seine sites were selected to represent as many intertidal habitats as feasible, and while many stations were sampled repeatedly during the summer, a few spot sets were made in each cruise to represent especially interesting habitats and to prevent the systematic neglect of major intertidal community variations. Seine sites included weedy, soft-bottomed habitats near the heads of bays, and protected and exposed sandy, gravel, and cobble beaches.

Figures 2-5 show sampling transects and stations for all gear types, although not all stations shown were sampled in each cruise. Table 1 presents the number of sets and standard hauls (defined in Methods of Analysis) for each gear type in each bay and cruise.

Processing Catches

Catches were sorted to the finest taxon feasible, usually to species. Specimens tentatively identified were saved for later laboratory examination.

In most cases we recorded the predominant life history stage of each species present in a haul. "Larvae" was recorded for fish thought not to have fully metamorphosed from the postlarval stage. "Juvenile" signified young of the year for gadids, gasterosteids, hexagrammids, trichodontids, *Oncorhynchus gorbuscha*, and *O. keta*, smelts and immatures for *O. nerka* and *O. kisutch*, and especially small individuals for *Salvelinus malma*. Pleuronectids under about 150 mm were arbitrarily called "juvenile" since we could not always distinguish young of the year and since 150 mm was the size above which sexes were usually distinguishable. This length may not be attained until the third year or so, depending on species. For most other species "juvenile" was recorded for fish in the smallest one or two apparent length classes. "Adult" was recorded for other specimens, and obviously our use of the term does not necessarily connote sexual maturity.

Usually the catches were entirely sorted and counted. Our pelagic sampling and beach seining, however, frequently yielded large catches of small fish, and in those cases a volumetric estimation of "numbers was made.

Species represented in small numbers were first separated and counted directly. Then a single random subsample was chosen to displace exactly 200, 500, or 1000 ml of water, depending on the size of the fish. Fish in the subsample were counted by species and usually retained for length measurements. The volume of the remaining catch was found by water displacement, and thereby catch in numbers of each species could be estimated proportionately. This technique was also employed when fish were inextricably mixed with large quantities of shrimp or jellyfish.

With few exceptions total length measurements (in mm) were recorded for all fish or a subsample of fish from every haul. When subsampling we attempted to obtain measurements from the full range of sizes present in the catch, although we did not practice truly proportional subsampling.

Stomachs were taken from selected fish which had been injected with 10% formalin immediately after capture or from uninfected fish caught within one hour to prevent excessive post-capture digestion. Stomachs were labelled, tied to prevent loss of contents, and after fixation they were transferred to 40% isopropyl alcohol. Small fish saved for food habits analysis were preserved whole, after slitting the abdominal cavity, and dissected later.

Physical Measurements

Temperature and salinity were the principal physical variables measured. Surface temperatures (± 0.1 C) were read from a protected laboratory thermometer, an unprotected reversing thermometer, and from a Beckman R55-3 induction thermometer/salinometer. Midwater temperatures were taken by a bathythermograph in cruise 1, and by the Beckman salinometer in cruises 3 and 4. Nearshore salinity samples were returned to Seattle after cruises 1-3 and were there analyzed with a UW-PNL electrode salinometer (+ 0.1 ppt). The Beckman salinometer gave all measurements of pelagic salinities in cruises 3 and 4.

LABORATORY METHODS

Laboratory work consisted of specimen identification and stomach content analysis. Specimens which were unidentified or tentatively identified in the field were examined later in the laboratory. We used several published and unpublished keys and taxonomic descriptions, and tried to identify each specimen to the species level. Our identifications of juvenile and adult forms are very reliable, but larval identification received no special effort and should be viewed accordingly.

Stomach samples were transferred from formalin to 40 percent isopropyl for storage before examination. The contents of each stomach were examined separately to give as much detailed information as possible. The fullness of the stomach and the percent digestion of contents were first judged according to interval scales. Total wet weight of contents (±.01 g) was taken , and then each prey category, consisting of a taxon/life history stage combination, was counted directly or estimated by subsampling, and weighed (±.001 g). The extent of taxonomic identification varied, and was dependent on the degree of digestion, the general taxon , and the life history stage. Most prey were identified to class, order, or suborder.

METHODS OF ANALYSIS

We analyzed catch data in terms of catch per unit of effort (CPUE), and data from each gear type were analyzed separately to avoid making fallacious assumptions about relative efficiencies of the gear. To show distributional trends various regions within the bays were defined to correspond to major ecological or hydrographic features such as head of the bay, protected inlets, and exposed rocky shore (Fig. 2-5). Calculating mean CPUE values for various regions loses some precision compared to a station-by-station analysis, but it suffices to show the major distributional features and permits figures which are readily interpretable and unoccluded by often enormous sampling variability. Ugak Bay was divided into three regions (inner, middle, and outer) graduating from the protected, narrow head of the bay to the open and more exposed outer section. Kaiugnak Bay was divided into two similarly conceived regions (inner and outer). The nearshore zone of Alitak Bay was divided into four regions for analysis: 1) Deadman, 2) eastside, representing the rocky exposed beaches of the east side of the bay, 3) westside, consisting of the protected Moser and Kempff bays, and 4) Tannerhead, a shallow-profile, exposed sandy beach. The pelagic zone of Alitak Bay was broken into five relevant regions: 1) Deadman, 2) Hepburn, of particular interest because of its typically large concentrations of juvenile pink salmon, 3) westside, consisting of the several protected inlets, 4) middle, and 5) outer.

For each combination of cruise, region, and gear type the total catch of a species was divided by the appropriate number of standard hauls to arrive at the CPUE values. For the midwater trawl., tow net, and try net a standard haul was defined as one ten minute tow. A single set comprised one beach seine standard haul, and one 2.5-hr set of both trammel nets comprised one standard trammel net haul. For the few longer trammel sets, the number of standard hauls was simply the number of multiples of 2.5, ignoring any relation between set length and matchability.

RESULTS AND DISCUSSION

Distribution and Abundance

Appendix Table 1 provides a checklist of the 70 species caught in this study and their relative abundances and where and when they were caught. Appendix Tables 2-52 summarize all catch data in terms of catch per unit of effort (CPUE; mean number of fish/haul) of each species in the various regions of the bays, and these tables are arranged by bay, gear type (= habitat), and cruise. The salient results of this CPUE breakdown are presented visually via maps (Figures 6-23) showing geographical and temporal trends in relative CPUE of major species. The lengths of the bars on the maps reflect relative CPUE, and for each map the highest CPUE pictured is given for standardization,

Each bay is discussed separately, and a fourth section summarizes important *results* and compares and contrasts findings from the three study bays.

Ugak Bay

Surface: The surface waters of Ugak Bay contained, in order of decreasing relative abundance, large numbers of capelin (*Mallotus villosus*), Pacific sandfish (*Trichodon trichodon*), Pacific sand lance (*Ammodytes hexapterus*; almost only in cruise 1), and age-O pink salmon (*Oncorhynchus gorbuscha*). Capelin were represented by all life history stages, although mature (i.e., sexually dimorphic) adults were rare and present only in the first two cruises. Capelin were most abundant in the inner two-thirds of the bay, especially in the middle region and that part of the inner region east of about 152°53″ (Fig. 6A), The apparent decline of overall mean CPUE of capelin from 591.5 fish/haul in cruise 3 to 55.9 fish/haul in cruise 4 (cf. Appendix Tables 3 and 4) cannot be explained by distributional changes, as the midwater sampling in cruise 4 showed that large numbers of juvenile capelin were still in the bay at that time. It possibly reflects a seasonal change of depth distribution, however.

Age-O sandfish were caught on the surface in very small numbers in cruises 1 and 2, but in great abundance later (Fig. 7A). This suggests that there might be an influx of larval and/or juvenile sandfish into the bay in early July, but we cannot dismiss the possibility that increasing susceptibility to capture concomitant with growth was primarily responsible for the suddenly large catches in later summer. Juvenile sandfish were most abundant in the outer region of Ugak Bay.

The lack of townetting in cruise 1 hampers our study of epipelagic residence by juvenile pink and chum (0. *keta*) salmon. However, the several surface hauls made with the herring trawl indicated that some juvenile pinks were in the pelagic zone as early as late May (Appendix Table 5). Townetting in cruise 2 (late June) produced greatest numbers of pinks in the middle part of the bay (Fig. 8A), although the overall mean catch then was only about 1.5 fish/haul. In late July juvenile pinks were still mainly in the middle region of the bay, but the overall mean catch was near 13 fish/haul. In the fourth cruise (late August) the mean CPUE dropped to 5.7 fish/haul, which may be explained by outmigration or by greater gear avoidance concomitant with larger size, or both. Fig. 8A shows that in cruise 4 catches of young pink salmon increased toward the mouth of the bay, offering strong evidence that the fish were in the process of migrating out from the bay. Surface catches of young chum salmon were neither large nor consistent enough to permit similar inferences about distributional changes with time; the overall catch of age-O chum salmon was about 40% that of pinks, and most of that catch was from a single haul.

Other salmonid species found in the surface waters were, in order of decreasing CPUE, coho salmon (O. *kisutch*), sockeye salmon (*O. nerka*), and, incidentally, Dolly Varden (*Salvelinus malma*). The coho and sockeye salmon were caught in cruises 2-4, and had obviously smelted and entered marine waters the immediately past spring.

The surface trawling in cruise 1 indicated a considerable abundance of larval and juvenile sand lance (*A. hexapterus*) in the inner and middle regions of the bay (Appendix Table 5). Interestingly, this species was only incidental in surface catches in later cruises.

Other species caught regularly on the surface were postlarval and/or juvenile yellow Irish Lord (*Hemilepidotus jordani*), age-O greenings (*Hexagrammos* spp.), and age-O threespine sticklebacks (*Gasterosteus aculeatus*). The juvenile greenling could not be identified to species in the field, but subsequent laboratory examination proved these to be white-spotted greenling (*H. stelleri*) and masked greenling (*H. octogrammus*). Other incidental but notable surface catches were mainly juveniles of snake prickleback (*Lumpenus sagitta*), black rockfish (*Sebastes melanops*), Pacific herring (*Clupea harengus pallasi*), walleye pollock (*Theragra chalcogramma*), silverspotted sculpin (*Blepsias cirrhosus*), soft sculpin (*Gilbertidia sigalutes*), tubenose poacher (*Pallasina barbata*), and Bering wolffish (*Anarhichas orientalis*).

Midwater zone: Capelin and, in the last two cruises, sandfish were by far the most abundant species throughout the water column of Ugak Bay (Appendix Tables 6-8). As in the surface stratum, capelin were consistently most abundant in the inner and middle regions (Fig. 10A). Analyzing the diurnal catches by depth showed capelin to be present in all depth strata (incremented 9-20 m, 21-60 m, 61-100 m), with density generally increasing toward the bottom (Table 2A).

The midwater trawl first encountered juvenile sandfish in the third cruise (late July), although their earlier presence in the bay was verified by surface trawling. Sandfish occurred throughout the bay, but an exceptionally large catch was made in five hauls in the outer region in late August (Fig. 11A). Like the capelin, sandfish were distributed all through the water column but with highest densities in the deepest (61-100 m) stratum (Table 2A).

Larval, juvenile, and small adult sand lance occurred in the mesopelagic zone as well as on the surface in cruise 1, but subsequent midwater sampling yielded only incidental numbers (Fig. 12A). Sand lance were found principally in the inner two-thirds of the bay.

Other midwater species were also represented almost only by juvenile forms. Midwater salmonid catches were negligible, and considering that 19.5 standard midwater trawl hauls were made in the 9-20 m stratum over the summer, the data verify that juvenile salmon are surface dwellers. Larvae and juveniles of the yellow Irish Lord comprised the most abundant midwater cottid form, followed in order of decreasing abundance by *Triglops* sp. (probably T. *pingeli*), *B. cirrhosus*, *B. bilobus*, and G. *sigalutes*. Other incidental catches were larval and/or juvenile bathymasterids, walleye pollock, and snake pricklebacks.

The four nighttime midwater trawl hauls in the third cruise yielded capelin and sandfish but also juvenile and adult flathead sole (*Hippoglossoides elassodon*), rock sole (*Lepidopsetta bilineata*), snake prickleback, and adult ribbed sculpin *(T. pingeli*). In one night tow near Eagle Harbor the echosounder indicated a large aggregation over twenty meters deep and at least as long as the tow (1.3 km); the catch was almost entirely juvenile capelin. Daytime echosounding traces were invariably small and patchy, and usually turned out to be aggregations of invertebrates, principally Euphausiacea and Hyperiidea.

Nearshore zone: In terms of CPUE alone, the sand lance was by far the most abundant species in the intertidal zone. Sand lance were distributed throughout the bay, with highest densities apparently in the middle region (Fig. 13A). In each cruise almost the entire catch came from a very few hauls, substantiating that sand lance occur in dense schools or aggregations. They occurred most often over black sand and small gravel substrate, and in all tide stages.

Juvenile pink and chum salmon were also dominant intertidal species in the early part of the season (Appendix Tables 9-12). In late May they were mostly near the mouths of streams, although since we could not seine along the precipitous shoreline between bights and major streams, we cannot say how dispersed along the shore the young salmon may have been. The largest juvenile pink salmon catches in late May were from the head of the bay (including Hidden Basin), Saltery Cove, Eagle Harbor, and from Pasagshak Bay. As found for sand lance, young salmon were distributed along the shore in dense schools. Pink and chum salmon were usually found schooled together (at least they were frequently caught in the same hauls), and pinks generally outnumbered chums severalfold at least. Juvenile salmon catches generally declined through the summer, although one beach seine site in the northwest corner of Eagle Harbor was found to have a consistently large concentration of salmon fingerlings (Fig. 2 and 14A). In cruises 2 and 3 a large catch of both species was made at that site, and the third cruise catch of 10,000 was probably greatly underestimated. (The entire catch was released). Adult pink and to less extent chum salmon were encountered only in late July near the mouths of major streams.

Other salmonid species occurring in the intertidal zone included subadult and adult Dolly Varden, a few sockeye and coho smelts, and small numbers of coho fry (Appendix Tables 9-12). We suspect that the coho fry were somehow displaced from their usually lotic habitat. Dolly Varden were caught mostly in aggregations near the mouths of streams, especially along the south shore of the inner region and in Pasagshak Bay (Fig. 16A).

While the intertidal catches of juvenile salmon declined greatly by late July (except for the Eagle Harbor concentration just mentioned), juvenile greenling (*H. octogrammus* and *H. stelleri* mostly, and apparently fewer *H. lagocephalus*) were moving inshore where they metamorphosed from pelagic to littoral residents. This was first noticed in mid-June, but especially in late July greenling were caught in all stages of transition from the pelagic morph (countershaded, forked caudal fins) to the littoral morph (square caudal fins and typical adult markings and coloration). Greenling catches, consisting mainly of juveniles, increased throughout the summer (mean CPUE values were 0.3, 0.4, 3.9, and 4.6 fish/haul in cruises 1-4, respectively), and all three species were found mostly over small rock substrate covered with *Fucus* and/or *Ulva*.

Juvenile great sculpin (*Myoxocephalus polyacanthocephalus*) comprised the dominant intertidal cottid species, and they were most abundant in the inner region of the bay (Fig. 17A). In the first cruise many of these were around 20 mm total length and were surely young of the year. Silverspotted sculpin (*B. cirrhosus*), staghorn sculpin (*Leptocottus armatus*), padded sculpin (*Artedius fenestralis*), *Gymnocanthus* spp. (G. *galeatus* and G. *pistilliger* were several times identified, but specimens were recorded only to genus), and yellow Irish Lord were common in beach seine catches. Of ichthyological interest, two specimens of *Porocottus quadrifilis* were caught in the same haul, one fish being ochre and the other bright green.

Other intertidal catches included surf smelt (*Hypomesus pretiosus*), found only in Pasagshak Bay, largely young-of-the-year and juvenile pleuronectids (mostly rock sole, *L. bilineata*, but also starry flounder, *Platichthys stellatus* and sand sole, *Psettichthys melanostictus*), crescent gunnel (*Pholis laeta*), tubenose poacher (*P. barbata*), capelin (almost all of the adults were caught in late May), snake prickleback, herring larvae in late August, and threespine sticklebacks.

Subtidal catches were dominated by yellowfin sole (*Limanda aspera*), rock sole (*L. bilineata*), and snake prickleback (L. *sagitta*) in the try net, and by adult greenings (*Hexagrammos* spp.) , rock sole, adult sturgeon poachers (*Agonus acipenserinus*), and adult herring in the trammel nets. The principal try net catches of snake prickleback were in Saltery Cove and especially in Pasagshak Bay (Fig. 18A). Yellowfin sole were trawled mainly in the inner two-thirds of the bay, while rock sole catches generally increased toward the mouth of the bay (cf. Figs. 19A and 20A). Table 3 shows a consistent tendency for highest rock sole catches in the shallower water and highest yellowfin sole catches in the deeper littoral zone.

Despite the constant problem of kelp clogging the opening of the try net, nearshore trawling produced the greatest species richness of all gear types employed (Appendix Tables 13-15). Other notable try net catches were butter sole (*Isopetta isolepis*, almost only from Pasagshak Bay), juvenile and small adult greenings, juvenile halibut (*Hippoglossus stenolepis*), and several species never seen in beach seine catches, including ribbed sculpin (T. *pingeli*), plain sculpin (*Myoxocephalus jaok*), Alaska plaice (*Pseudopleuronectes quadrituberculatus*), Alaskan ronquil (*Bathymaster caeruleofasciatus*), Bering poacher (*Occella dodecaedron*), and Aleutian alligatorfish (*Aspidophoroides bartoni*).

The trammel nets produced especially large catches of masked greenling (*H. octogrammus*), rock greenling *(H. lagocephalus*), and whitespotted greenling (*H. stelleri*), in order of decreasing relative CPUE. These species were distributed throughout the bay, and all three species were caught in most sets, suggesting a considerable overlap of habitat (Fig. 21A, 22A, and 23A). Whereas yellowfin sole were more abundant than rock sole in try net catches, the reverse was true for trammel net catches (Appendix Tables 16-18) . Interestingly, large adult herring were caught by the trammel nets throughout the summer, and almost the entire catch came from the Pasagshak Bay site. Uncommon but noteworthy species in trammel net sets were red Irish Lord (*H. hemilepidotus*), kelp greenling (*Hexagrammos decagrammus*; only in the last cruise), and antlered sculpin (*Enophrys diceraus*).

Kaiugnak Bay

Surface: The capelin was by far the most abundant species in the epipelagic zone of Kaiugnak Bay, followed by sand lance, sandfish, and in incidental numbers by age-O *Hexagrammos* spp., pink salmon, and others (Appendix Tables 19-22). Sand lance of all life history stages were caught mainly in late May (in the surface trawl) , and in small numbers in late June. Capelin were caught all through the bay in all cruises, although catches in early September were very small (Fig. 6B). Sandfish were caught only in the last two cruises (Fig. 7B). Interestingly, juvenile pink salmon were relatively uncommon in Kaiugnak Bay; only 11 fish were caught during the entire summer. Other surface catches included sockeye salmon smelts (undoubtedly immigrants from another estuary system since there is no lacustrine habitat in the drainage immediately around Kaiugnak Bay), tadpole sculpins (*Psychrolutes paradoxus*), juvenile prowfish (*Zaprora silenus*), threespine sticklebacks, and juvenile rock and flathead sole.

Midwater zone: In late May sand lance comprised the dominant mesopelagic species, albeit in small numbers (Fig. 12B, Appendix Tables 23-25). In subsequent cruises, however, capelin and sandfish were the only common midwater species. Capelin and sandfish were distributed throughout the bay, and sandfish were especially abundant in the outer bay in early September (Fig. 10B and 11B). Both capelin and sandfish tended to be most abundant in the deeper strata, although because each depth stratum is represented by only one or two hauls, Table 2B also shows a considerable catch variability. Besides capelin, sand lance, and sandfish , only larval and/or juvenile yellow Irish Lord , snake prickleback , walleye pollock, prowfish, bigmouth sculpin (*Hemitripterus bolini*), and unidentified postlarval bathymasterids were found in the midwater habitat (Appendix Tables 23-25).

Incidental catches of crustacea were generally higher in Kaiugnak Bay than in Ugak Bay. Large zooplankters retained in the midwater trawl and tow net were Euphausiacea, Hyperiidea, decapod zoea, at times large quantities of small shrimp (*Pandalus borealis* and/or *P. hypsinotus*), and many hydrozoan medusae and scyphozoans.

Nearshore zone: Sand lance overwhelmingly dominated intertidal catches all through the summer, and were especially abundant in the inner region of the bay over small gravel and sand substrate (Fig. 13B). As before the huge variability of sand lance catches reflected a highly clustered distribution. Juvenile pink salmon were next in abundance, and were caught chiefly on the exposed side of the spit enclosing the lagoon at the head of Kiavak Bay (Fig. 3 and 14B). Catches of juvenile salmonids declined sharply by late July, and none were caught in early September (Fig. 14B and 15B). Adult pink and in less abundance chum salmon were caught in late July in aggregations near a small stream feeding the head of the bay and near the Kiavak lagoon. A large number of juvenile sandfish occurred in beach seine catches, although most of these were from a single set in moderate surf on the north shore of the outer region (Fig. 3). Juvenile great sculpin comprised the bulk of intertidal cottid catches, and were most abundant in the more protected inner region of the bay (Fig. 17B). Juvenile greenling catches increased over the summer, and as in Ugak Bay masked greenling were most abundant followed by whitespotted and rock greenling (Appendix Tables 26-29). There were especially many juvenile greenling in the Kiavak lagoon, where the substrate was small rocks heavily covered with *Fucus*. Sexually dimorphic capelin were seined only in late May at a sandy beach at the head of the bay. Other beach seine catches were young-of-the-year threespine sticklebacks, silverspotted sculpin, tubenose poacher (*P. barbata*), crescent gunnel (*P. laeta*), a few Dolly Varden, and mainly juvenile rock sole and starry flounder.

The try net was used at three sites in Kaiugnak Bay, and only at the Kiavak site (Fig. 3) was sampling generally unimpeded by kelp clogging the net. The snake prickleback (*L. sagitta*) was the dominant species in try net catches, although only in cruises 2 and 3 and only in the outer region of the bay (Fig. 18B). Pleuronectids were next in abundance, and rock sole were consistently more abundant than yellowfin sole (Appendix Tables 30-32). The yellowfin sole was more evenly distributed through the bay than was the rock sole, which was caught almost only in the outer region (Fig. 19B and 20B). Analyzing try net catches by depth failed to indicate any consistent trends in depth utilization by rock sole and yellowfin sole as were found in Ugak Bay, although the considerably smaller catches of both species in Kaiugnak Bay may pertain to this result. Pleuronectids encountered incidentally were sand sole (*P. melanostictus*), Pacific halibut (*H. stenolepis*), butter sole (*I. isopsetta*), and flathead sole (*H. elassodon*). The greenings were second to pleuronectids in relative abundance, and the masked greenling was consistently the dominant hexagrammid. Greenling catches increased throughout the summer, reflecting recruitment of juveniles to the nearshore zone. A total of ten cottid species were caught by the try net, including *Gymnocanthus* spp., *Triglops* sp., red and yellow Irish Lord (*H. hemilepidotus* and *H. jordani*), silverspotted sculpin, three species of *Myoxocephalus*, and, interesting from a zoogeographical perspective, the manacled sculpin (*Synchirus gilli*). Other incidental try net catches were tubenose and sturgeon poachers, penpoint gunnel (*Apodichthys flavidus*), tubesnout (*Aulorhynchus flavidus*), and Arctic shanny (*Stichaeus punctatus*).

Rocky subtidal (i.e., trammel net) catches were mostly of adult masked, rock, and whitespotted greenling (Appendix Tables 33-35). All three species were abundant throughout the bay (Fig. 218, 22B, and 23B). The rock sole was the only pleuronectid caught by the trammel nets in Kaiugnak Bay. Other noteworthy catches were adult black rockfish (S. *melanops*; only in the outer region), kelp greenling (again, only in the last cruise), great sculpin, and Alaska ronquil (*B. caeruleofasciatus*).

<u>Alitak Bay</u>

<u>Surface:</u> In terms of numbers alone, the capelin was by far the most abundant species in the epipelagic zone, although essentially all of these were larvae and small juveniles caught in a few hauls in the Hepburn region in mid-September (Appendix Tables 36-39). Interestingly, the larvae were caught in three diurnal hauls, and all of the juveniles were caught in a few nighttime hauls. Only one capelin was caught on the surface in other cruises, a marked contrast from the night catches from other bays.

Juvenile pink salmon were the most consistently abundant epipelagic residents, and were especially abundant in the lower Deadman region and in the Hepburn region (Fig. 8B). The diurnal pink salmon catches in Alitak were notably more variable than the nocturnal catches in Ugak Bay, evinced by several instances when catches of from several hundred to over a thousand fingerlings were preceeded or followed immediately by one to several empty hauls. The mid-September catches were drastically reduced relative to earlier levels (Appendix Table 38, Fig. 8B), making us wonder whether the negligible catches reflected outmigration or to some extent perhaps diurnal aversion of surface waters by the larger juveniles. Six nocturnal tow net hauls were made in the lower Deadman and Hepburn regions, and the total catch of only three juvenile pinks suggested that the fish were either staying below the surface throughout the diel period or had mostly left the bay, or perhaps both.

Juvenile greenings were encountered more in Alitak Bay than in the other bays, and especially large catches were made in the outer region in late June (Fig. 9).

All other surface catches were incidental. Larval sand lance and bathymasterids were caught in late June, and other catches included a few juvenile chum, sockeye and coho salmon smelts, Dolly Varden, juvenile and adult threespine sticklebacks, yellow Irish Lords, black rockfish, juvenile tiger rockfish (*Sebastes nigrocinctus*) and lingcod (*Ophiodon elongates).*

Midwater zone: The capelin was substantially more abundant than any other. species in the mesopelagic habitat (Appendix Tables 40-42). Capelin were all through the bay, but the largest catches were from the inner two-thirds of the bay (Fig. 10C). The largest catches were generally from the sets nearest to the bottom, although this result is occluded in Table 2C since the bottom contour of Alitak Bay is very irregular and the table is incremented by depth and not by distance from the bottom.

The juvenile sandfish population of Alitak Bay is apparently small, as none were caught on the surface and only in the outer region in cruise 4 were any appreciable numbers caught by the midwater trawl (Fig. 11C).

Other common midwater species were slender eelblenny (*Lumpenus medius*), represented by larvae and small juveniles in mid-September, adult herring, sand lance (early in the summer), and, interestingly, Alaska eelpout (*Bothrocara pusillum*) which were found only in the deepest strata of the Deadman region (Table 2C). Seventy four juvenile pink salmon were caught in an 18 m set in the outer region in cruise 3, but it is distinctly possible that they entered the trawl from the surface at the start or end of the tow. Other midwater catches were a few juvenile greenling, adult and juvenile cottids, prowfish, and smooth lumpsucker (*Aptocyclus ventricosus*).

Nearshore zone: As in the other bays, the sand lance was the numerically dominant species in the intertidal zone of Alitak Bay (Appendix Tables 43-46); about 75% of the total catch came from a single haul on a sandy beach near Shag Bluff (about 56°56′ N, 153°53′ W) in mid-September (Fig. 13C).

Juvenile pink and chum salmon were abundant in late May at the head of Deadman Bay. Although chum salmon appear to have been more abundant than pinks, almost the entire catch of young chum came from a single haul. Juvenile pink catches were never as great as in the other bays (cf. Fig. 14A-C).

Other salmonid catches included Dolly Varden, again found mostly in aggregations near streams throughout the bay (Fig. 16B), recent smelts of sockeye and coho salmon, and adult pink salmon in the last two cruises.

Metamorphosing juvenile greenling were first seined in late June, and were quite abundant in the last two cruises (Appendix Tables 43-46). Predictably, the juvenile greenling were caught mostly over small rock and cobble substrate with profuse growths of algae. As in the other bays, juvenile masked and whitespotted greenling were much more numerous than juvenile rock greenling.

The dominant intertidal cottid was the great sculpin, represented mostly by young of the year and other juveniles in the more protected Deadman and westside regions (Fig. 17C).

Other intertidal catches were incidental, and were similar to those from Ugak and Kaiugnak Bays (Appendix Tables 43-46). Several nighttime seine sets at the head of Deadman Bay are noteworthy, as large juvenile " (probably age 1) Pacific cod (*Gadus macrocephalus*) and pollock, and adult herring were caught, indicating nocturnal use of the immediately nearshore zone by these forms.

The try net sampling in Alitak Bay was greatly hampered by especially large growths of kelp in the few areas suitable for nearshore trawling. Unfortunately, no workable try net sites were found in the Deadman region.

The sand lance was the most abundant species caught by the try net in numbers alone, but the entire catch came from a single haul near Shag Bluff. Interestingly, that haul was offshore from and nearly simultaneous with the beach seine haul that yielded over 20,000 sand lance, suggesting that the aggregation was quite large.

The most consistently abundant subtidal forms were rock sole and juvenile and small adult greenings (Appendix Tables 47–49). Pleuronectid catches were always highest in the western half of the bay, and particularly at the Tannerhead site for rock sole (Fig. 20C), sand sole, and juvenile halibut. The catches of yellowfin sole were noticeably depressed, but were also predominantly from the western part of the bay (Fig. 19C).

Appendix Tables 47-49 show again a consistent increase of greenling catches over the summer, attributable to the change from pelagic to littoral residence by juveniles. The masked greenling was again the most abundant hexagrammid.

The remaining try net catches were similar to the incidental catches from the other bays; *Gymnocanthus* spp., the great sculpin, shorthorn sculpin (*M. scorpius*), red and yellow Irish Lord, and *Blepsias* spp. were the principal cottid species, and the crescent gunnel, snake prickleback, and Arctic shanny (S. *punctatus*) comprised the blennioid fishes.

Trammel nets set over rocky substrate produced large numbers of masked, whitespotted and rock greenings, in order of decreasing CPUE (Appendix Tables 50-52). Masked greenling were distributed all through the bay (Fig. 22C), but the rock and whitespotted greenings seemed to be more stratified. Rock greenling were caught almost only in the eastside region (Fig. 21C), while whitespotted greenling were chiefly in the westside and particularly Deadman regions (Fig. 23C). In retrospect, the same trend for whitespotted greenling is seen in beach seine and try net catches (Appendix Tables 45-49).

Other trammel net catches included the usually small numbers of large juvenile cod and *Myoxocephalus* spp., but also in the fourth cruise the Atka mackerel (*Pleurogrammus monopterygius*) and decorated warbonnet (*Chirolophis polyactocepha 224s).* Five adult sockeye salmon were caught in the trammel net set in late June near the entrance to Olga Narrows (Fig. 5).

Summary, and Comparison of Bays

The principal pelagic fish fauna in all bays was: capelin, sandfish, juvenile pink salmon, and predominantly larvae and juveniles of sand lance, herring, stichaeids, bathymasterids, cottids, and scorpaenids.

Larval, juvenile, and adult sand lance were abundant in the pelagic zone of all bays in the early part of the summer, but catches declined to only incidental occurrences in the last three cruises (late June to September). This probably reflects a general shift to benthic and/or littoral habitats in midsummer, but some outward movement may occur as well. Bottom trawling by the Alaska Department of Fish and Game (ADF&G; OCS R.U. #486) produced almost no sand lance in Ugak and Alitak bays (Kaiugnak Bay was not sampled), suggesting that the population occupies mainly littoral habitats in later summer. However, the fish may have been unsusceptible to capture by the 400 mesh Eastern otter trawl used in that survey. Barraclough, Robinson and Fulton (1968) also found an early-summer decrease in pelagic larval sand lance catches in their tow net sampling of Saanich Inlet near Vancouver Island.

The capelin was the principal pelagic species in all bays, and was represented overwhelmingly by larval and (suspected) yearling fish. Very few sexually dimorphic fish were caught in the pelagic zone, especially in the later cruises. There is strong albeit indirect evidence for diel vertical movements of capelin. Large numbers were caught on the surface in nocturnal townetting in Ugak and Kaiugnak bays, while essentially none were caught in diurnal townetting in Alitak Bay (except for larvae in the last cruise only). The midwater trawl, however, proved that capelin were abundant in Alitak Bay. Further, the only surface catches of juvenile capelin in Alitak Bay were from the few nighttime sets around Cape Hepburn. The markedly low surface catches of capelin in the last cruise in Ugak and Kaiugnak bays suggest a seasonal change in depth utilization by capelin, since they were still very abundant in the midwater strata (cf. Fig. 6A and B).

A few postlarval and small juvenile sandfish were caught in late May and June, but by the latter half of the summer they comprised the second most abundant pelagic species in the study area. Interestingly, Alitak Bay seemed to have a smaller population of juvenile sandfish than the other bays, and the overall abundance sharply declined toward the southern half of the island (cf. Fig. 11A-C). The largest catches occurred in the mouths of the bays in the last cruise, which suggests concentration in the outer regions concomitant with movement out of the nursery bays. The bottom trawling by ADF&G yielded few sandfish in Ugak and Kaiugnak bays in June, but larger numbers in late summer (James Blackburn, unpublished ins.; personal communication). Also, the mean weight of sandfish decreased from 77 gm and 132 gm in June and July, respectively, to 9.5 gm in August, suggesting that juveniles were moving from pelagic to benthic habitats. There were also many more sandfish in Ugak Bay than in Alitak Bay in that study. Diel vertical migrations of juvenile sandfish are hinted by large catches in nocturnal townetting and null catches in diurnal surface sampling, but the

Alitak Bay population was so small that the null diurnal catches could be explained by sampling variability alone.

Juvenile pink salmon were abundant in surface waters in day and night in late June and early August, but were obviously moving out of the bays in late August to mid-September. The surface trawl in cruise 1 indicated at least a few juveniles in the pelagic zone of the bays as early as late May, The largest catches of juvenile salmon were from the middle region of Ugak Bay and from the lower Deadman and Hepburn regions of Alitak Bay in late June and late July. By mid-September Ugak Bay catches were highest in the outer region, suggesting ongoing outmigration, and Alitak Bay catches were negligible in day and night, suggesting that the fish had largely left the bay by that time. However, several unmeasured factors must be considered in interpreting our catch data, including:

1) the fish caught in outer Ugak Bay may have included some outmigrants from other bays,

2) the negligible catches in Alitak Bay may be partly due to a presumed low probability of intersecting diurnal schools in the expansive outer regions of the bay,

3) larger juveniles may prefer subsurface waters (i.e., below the footrope of the tow net) or otherwise easily avoid the gear in daytime.

There was evidence for more catch variability in our diurnal sampling than in nocturnal sampling, but we cannot separate differences due to bays. Tyler (1972) discusses diel effects on catch variability in more detail.

FRI has townetted several bays on Kodiak Island annually since 1963 to provide a forecast of pink salmon runs to the island. Sampling usually took place from late June to early August. In every year but 1975, the Hepburn/Portage Bay and lower Deadman regions of Alitak Bay have hosted large concentrations of juvenile pink salmon, evinced by catches of from several hundred to several thousand per 10 minute haul (Richard Tyler, Bob Donnelly, unpublished data). Much smaller numbers have been found in the westside bays, and catches of only a few fish have regularly occurred in the outer region of the bay. In 1975, interestingly, the Hepburn area yielded only moderate catches yet the westside bays provided catches up to 15,000 fish per haul. One haul in Moser Bay yielded about 30,000 fish. While the Hepburn and lower Deadman regions of Alitak Bay usually have concentrations of juvenile pink salmon (and chum salmon, albeit in much less abundance), the 1975 results show that the distribution pattern is subject to considerable variation. The distribution pattern for Ugak Bay has historically been very similar to that found in the present survey.

Juvenile masked and whitespotted greenling were present in the epipelagic zone of all bays in early summer, although large catches occurred only in Alitak Bay in late June. Pelagic greenling catches fell to incidental numbers by late July and to negligible levels in ‘the last cruise as the fish gradually took up residence in littoral habitats.

Many more species were encountered in the nearshore than in the pelagic zone. Juvenile sand lance and salmon were the most abundant intertidal fishes, and since they school they likely have clustered albeit probably shifting distributions. Greenings, pleuronectids, cottids, and to a lesser degree Dolly Varden, herring, and blennioids comprised the bulk of the remaining nearshore community.

Although sand lance were found chiefly in the inner regions of Ugak and Kaiugn'ak Bays, the enormous sampling variability associated with the species precludes a firm statement about their distribution within the bays. In all cases, however, they were seined over sand or small gravel substrate, and probably any such beach in the study area is likely to host sand lance. We cannot infer from our catches a seasonal. peak of abundance, again because of the large sampling variability. Nevertheless, because the pelagic catches of juveniles and adults declined sharply by late June, there is indirect evidence for an increase in the littoral sand lance population in early summer.

Juvenile pink and chum salmon were abundant in the littoral zone of all bays in late May and late June, but had almost entirely moved into pelagic areas by late July. An exception was the enormous intertidal catch of juvenile pinks and chum from the northwest corner of Eagle Harbor, Ugak Bay, in early August. It may be that this aggregation was a large diurnal school of typically pelagic fish that either at random or in some directed fashion ranged inshore.

Adult salmon were first encountered nearshore in late June when five sockeye and one chum were caught in the trammel nets near the entrance to Olga Narrows (Fig. 5). The main adult catches were largely of pink salmon near the mouths of streams in late July.

Because our gear types and discontinuous sampling program provided little information on the adult salmon runs to the bays, supplementary information was gleaned from the literature. Catch and escapement data compiled by FRI and ADF&G provide indirect but useful indications of timing and size of runs to various bays and even to particular river systems within the bays. The pink salmon is the principal salmonid species on Kodiak Island; catches of pinks make up an average of 84% of the total salmon catch from Kodiak in odd years and 96% in even years (Stern, unpublished ins.). Stern shows the average timing of pink runs to Kodiak as the third week of June to the first week of September, with a peak in late July/early August. In some years and near some river systems the peak catches may be in the second week of August (Manthey, Malloy, and McGuire, 1975; Bevan, Lechner, and Eaton, 1973). The main Kodiak sockeye salmon runs are to Karluk and Red rivers, but a few streams in Olga Bay (connected to Alitak Bay) also support commercially important runs. Smaller numbers of sockeye return to Ugak Bay, particularly to the Pasagshak River. Sockeye salmon return to the estuaries considerably earlier than the pink salmon. Small numbers of sockeye are in the rivers as early as late May (Gwartney, 1969), but the runs to the Olga Bay rivers usually begin in early June (Eaton, 1968; Bevan, Pedersen, and Manthey, 1975; Russell, 1972). Peak sockeye catches from the bays occur in the third week of June (Stern, unpublished ins.).

Figure 24 shows the major spawning streams in the study area by species, as identified in this study and as mapped by Atkinson, Rose, and Duncan (1967).

Dolly Varden were common in all bays and throughout the field season, usually in aggregations near the mouths of streams. A few individuals were caught by the tow net in Ugak and Alitak bays.

The greenings *(H. octogrammus, H. stelleri,* and *H. lagocephalus*) were the most consistently occurring species in the nearshore zone. Yearling and suspected age-2 greenings were caught in the intertidal and subtidal zones by the beach seine and try net, and almost all of the larger adults were caught by the trammel nets. A more detailed length frequency analysis is presented later, but the mean lengths of fish caught by beach seine, try net, and trammel net, respectively, were 125.4, 144.3, and 205.2 mm for h'. *octogrammus* (n = 479,241 and 392), and 93.5, 135.5, and 248.5 mm for *H. stelleri* (n = 413,151 and 144). An a priori orthogonal comparison of lengths from beach seine and try net versus trammel net samples was highly significant for both species (for H. *octogrammus* $t = -25.97$, $p < .001$ and for *H. stelleri* $t = -35.24$, $p < .001$; data pooled over all bays and cruises), although in both cases the variances were heterogeneous. We cannot conclude whether these size differences are primarily due to a considerable degree of habitat separation between mature and younger greenling, or whether differential avoidance of active and passive gear by large and small fish had the dominant effect on catch data. We suspect that mature adults occupy a more strictly rocky, vegetated habitat and that younger age groups range more frequently into intertidal smooth, sandy subtidal areas, but that our data perhaps exaggerated the tr[illegible] because of respective catchabilities of the gear. Spawning by masked 1 rock greenings was first observed in late June, indicated by ripe . and running eggs and male breeding coloration. By the third cruise many whitespotted greenling were in spawning condition, and by mid-September female masked and rock greenling were spent and male breeding colors were fading. Whitespotted greenling were still in spawning condition during the last cruise. Interestingly, very few juvenile rock greenling were caught in pelagic or nearshore habitats, yet the adult population was commensurate with those of masked and whitespotted greenling. Only a few adult kelp greenling *(H. decagrammus*) were caught, and only in outer Kaiugnak and Ugak bays in the last cruise. This may be a reasonable result of sampling variability given a small population of the species in the study area, but the results suggest a larger population outside the mouths of the bays (perhaps in the large kelp beds just offshore or along the rocky outer coast) which fringes just inside the bays in later summer.

The dominant pleuronectids in the nearshore zone were mainly juveniles of the yellowfin sole and the rock sole. Catches of both species were highest in Ugak Bay, where yellowfin sole occurred mostly in the inner bay and rock sole catches increased toward the mouth of the bay. For both species the catches were highest in later summer, reflecting the influx of young of the year to the nearshore habitats. Surprisingly, no postlarvae were identified in the entire study, but the smallest age-0 fish caught in August and mid-September had apparently just completed metamorphosis. Very few flathead sole were caught in the nearshore zone. ADF&G's benthic survey, in contrast, showed the flathead sole to be the second most abundant flatfish in the deeper parts of the bays. Young halibut were caught sporadically in all bays, but a concentration of age-0 halibut was found in mid-September on the sandy habitat at Tanner Head in Alitak Bay. Consistent with this result, the shallow banks just outside Alitak Bay and near the Trinity Islands off south Kodiak Island have been found by the International Pacific Halibut Commission (IPHC, 1964; Best, 1974) to host large numbers of juvenile halibut. Butter sole were caught mainly in Pasagshak Bay within Ugak Bay, and in small numbers in outer Kaiugnak Bay. Starry flounder and sand sole were also common nearshore.

The great sculpin was the most abundant nearshore cottid, and was also frequent in the benthic samples of ADF&G. Catches were highest in the early summer when young of the year were present in the more protected regions of the bays. Large adults were rare in the intertidal zone relative to the subtidal areas. Congeners were the shorthorn sculpin and plain sculpin, the latter caught only in the subtidal zone.

Other nearshore species were already mentioned in earlier sections, and are listed in the Appendix Tables. In several cases our incidental catches constituted geographic range extensions. For information on geographic distributions we have relied heavily on Andriyashev (1954), Hart (1973), Wilimovsky (1954, 1958), Quast and Hall (1972), and various unpublished literature. With these range extensions goes the caveat that we may have missed published records documenting some or all of these species in the Kodiak area:

1) Tube-snout, *Aulorhynchus flavidus*. This species was reported by Quast and Hall (1972) to range from Baja California to southeast Alaska, and was previously reported in Kodiak waters by Tyler (unpublished).

2) Plain sculpin, *Myoxocephalus jaok*. The last range extension that we know was eastward, to Cold Bay, Alaska (Quast and Hall, 1972).

3) Manacled sculpin, *Synchirus gilli*. The last northward range extension was to Sitka, Alaska, reported by Miller and Erdman (1948).

4) *Porocottus quadrifilis*. Andriyashev (1954) mentioned that this species is restricted to the Bering Strait. Our specimens may be *P. bradfordi* which has been recorded on Kodiak Island (Rutter, 1898).

5) Bering poacher, *Occella dodecaedron*. According to Quast and Hall (1972), the southeastern extent of the range is the Alaska Peninsula.

6) Bering wolffish, *Anarhichas orientalism.* Quast and Hall (1972) reported the range as from the Sea of Okhotsk to Bristol Bay, but it appeared in our catches as well as in the incidental catches of past FRI townet sampling around Kodiak Island (Bob Donnelly, personal communication).

This section on distribution and abundance would be incomplete, or at least misleading, without a word on fishes not caught by our sampling. Regardless of the types of gear employed or the amount of effort, there is always a probability that at least one extant species is never represented in the catches. To illustrate this, in each cruise of this survey a number of species were encountered for the first time; on the last cruise, for instance, 12 species were added to the checklist (Appendix Table 1). To some extent this result may be due to seasonal changes in distribution (e.g., fish moving into the bays or into the nearshore zone), but even without considering such dynamics the same result might be expected on the basis of multinominal probabilities. In short, our results reflect the major constituents of the estuarine fish fauna, but there are perhaps many species inhabiting the pelagic and nearshore zones of the study area which were not encountered.

General Description, Age-Class Composition, and Food Habits of Major Species

Because most of our nearshore and pelagic catches were mainly of juvenile fishes, length frequency graphs for major species are broken down by cruise to reflect growth of the early age groups. When feasible the same abscissa scale is used for all graphs for a species, and the length intervals have lower boundary points (e.g., 40-44, 45-49; 70-79, 80-89, etc.). In all cases the ordinate is the percentage of the total sample contributed by the length intervals. Since seasonal growth was deemed an important factor, length data were usually pooled over all bays and gear types to provide samples sufficiently large to warrant graphing. Consequently, the following graphs are not length frequencies in the strictest sense since no allowance was made for different catchabilities by size of the various gear types. Nevertheless, they suffice to identify the major size classes represented in the samples.

We examined all stomach samples collected in this survey, and recorded for each predator specimen the prey taxa and life history stages (including the genre organic debris, parts of organisms, and unidentified material), total wet weight (± .01 gm) of stomach contents, and count and wet weight (± .001 gm) for each prey taxon/life history stage category. The data were processed by a FORTRAN program to provide the statistics needed to prepare Indices of Relative Importance (I.R.I.), similar in design to those of Pinkas et al. (19?1), and useful in graphically describing three important variables of a species' food habits: frequency of occurrence of a prey category, and percent composition of a prey category in terms of numbers and total consumed biomass. The three-way I.R.I. graphs show for a sample of nonspecific predators: 1) on the horizontal axis, the percent frequency of occurrence of each prey category (that is, the fraction of the entire sample of stomachs that contained at least one individual of the category), 2) on the vertical scale above the horizontal axis, the percentage of the total number of prey items in the sample contributed by each category, and 3) below the horizontal axis, the percent contribution of each category to the total weight of all identified prey items in the sample. Unless otherwise stated, all three variables are drawn so that 1 mm = 1%. Categories represented by less than 5% for frequency of occurrence and by less than 1% for the other variables were not included on the I.R.I. graphs.

Pacific herring, *Clupea harengus pallasi*

The Pacific herring is caught commercially in the Kodiak Island area, and the main fishery is on the west side of the island (Manthey, Malloy, McGuire, 1975; Reid, 1971). The Kodiak herring fishery was quite large before the late 1950's (an average of 40,000 tons were harvested annually from 1934 to 1950, and the largest catch in 1934 was nearly 121,000 tons), but processing herring for oil and meal became unprofitable causing closure of plants and a sharp decline in catches. Currently there is a limited fishery for roe herring. The average annual catch from 1970 to 1974 was only 441 tons (Manthey, Malloy, McGuire, 1.975).

Most of the non-larval herring encountered in this study were large . adults caught by the trammel nets in outer Ugak Bay (specifically, in Pasagshak Bay) and small adults caught in two midwater trawl hauls in outer Alitak Bay. The largest individual was 332 mm and the smallest fish were young of the year about 30-60 mm long (Fig. 25). Large fish (over about 260 mm) were nearshore in Pasagshak Bay throughout the summer, certainly well after the spawning season which according to Rounsefell (1930) is May-early June for the Kodiak-Afognak area. Svetovidov (1952) mentioned that various races of Pacific herring stay inshore to feed after spawning. According to length and age information from Rounsefell (1930) and Reid (1971), the adult herring caught by the trammel nets were from about 5 to near 20 years old. Alaska herring mature at age III or IV (Reid, 1972).

Only 11 age-O herring were examined for food habits, and the small sample size does not warrant graphing. All of the fish had recently fed, and over 99% by numbers and weight of the pooled stomach contents consisted of calanoid copepods, followed by a few harpacticoid copepods.

Pink salmon, *Oncorhynchus gorbuscha*

The summer growth of juvenile pink salmon pooled over all bays and gear types is illustrated in Fig. 26. Several important factors affecting growth of estuarine juvenile salmon beg a more elaborate analysis, however. For example, the young fish grew so fast that much of the variance of the distributions shown in Fig. 26 is due to the growth that occurred within the approximately 2-week cruises. Also, we might expect habitat to pertain to fish size, since juvenile pinks are generally nearshore early in the summer and in epipelagic areas later (Tyler, unpublished; Manzer, 1956).

Figures 27 and 28 show the mean lengths of fish caught in the intertidal (beach seine) and epipelagic (tow net and midwater trawl) hauls from Ugak and Alitak Bays, respectively, plotted against sampling date. The means are either from single samples or are grand means from two or more samples taken on or close to the sampling date indicated.

The implied curves in Figures 27 and 28 hint exponential growth, as would be expected for very young fish. We suspect that the early-September sample means are lower than the population mean(s) at that time (that is, the last growth increment indicated was probably larger than shown). Since the peak of outmigration is in August and since timing of outmigration appears to be related to size (Tyler, unpublished), the juveniles remaining in the bays in September may represent the smallest fish of the cohort, Also, bias toward smaller fish in the later cruises may have accrued from more effective gear avoidance by the larger fish.

In a preliminary analysis, the mean lengths of fish caught intertidally were significantly less than the mean lengths of epipelagic fish in cruises 2 and 3, as expected. However, Fig. 27 shows that these differences were to some extent artifacts of our sampling since in both cruises the intertidal samples were taken earlier than the pelagic samples. Consequently, much of

-the disparity between means from nearshore and epipelagic samples may have. been made up by the growth that occurred in the few days (10 days for cruise 2, 3 days for cruise 3) between the beach seine and tow net sampling. For example, Ugak Bay fish grew an average of 1.05 mm/day (an estimate calculated by dividing the difference between the intertidal means from cruises 2 and 3 by the 30 days separating the samples), and therefore as much as 1.05 cm of the 1.11 cm difference between intertidal and pelagic sample means from cruise 2 may be explained by growth that occurred in the 10 day interval. The fish caught intertidally in Alitak Bay in cruise 2 were obviously smaller than pelagic fish, however.

The diets of juvenile pink salmon differed greatly between nearshore and pelagic habitats (Fig. 29 and 30). Fish caught by the beach seine, pooled over all bays and cruises, fed mostly on epibenthic harpacticoid copepods. Gammaridean amphipods, fish eggs, and miscellaneous larval crustacea contributed to the diet in terms of numbers, but very little in terms of weight (Fig. 29). Pinks caught in the epipelagic zone (day and night samples combined) ate mainly calanoid copepods, barnacle cypris larvae, miscellaneous crustacean nauplii, harpacticoids, and fish eggs. Larval capelin contributed most of the weight in the entire sample, but came from the stomachs of only a few large juveniles.

The most recent and detailed study of food and feeding habits of Kodiak Island pink salmon was by Gosho (1977). He studied the diets of epipelagic juvenile pink salmon collected from Kiliuda Bay (just south of Ugak Bay) and Alitak Bay in the summer of 1971, and attempted to relate food habits with the results of concurrent zooplankton sampling. His study pointed out many factors that affect the diet of young pinks, including season, time of day, and location within the bays. The diets of fish in his samples included mainly copepodids, nauplii, decapod zoea, and planktonic eggs in the day, and barnacle cypris, insects, pteropods, copepodids, zoea, and *Oikopleura* at night.

Stern (unpublished ins.) reviewed the general life history and biology of pink salmon, as well as other salmonid species, in the Kodiak area.

Chum salmon, *Oncorhynchus keta*

Juvenile chum salmon were noticeably larger than juvenile pinks in late May when both species were abundant in beach seine samples. The chum averaged 43.5 mm, significantly more than the 37.0 mm mean for pink salmon (two sample t-test, $t_{(282\ df)} = 12.39$, $p < .001$).

There was a great disparity between the mean sizes of nearshore and pelagic fish throughout the summer, especially in cruise 2 when it resulted in a bimodal length frequency distribution (Fig. 31). A plot of means from nearshore and pelagic samples from Ugak Bay is presented in Fig. 32 (relatively few fish were caught in the other bays). For the cruise 2 (late June) samples, the difference between nearshore and pelagic means was about 5.3 cm, which is clearly significant and which explains the bimodal distribution in

Fig. 31. Nearshore fish were also smaller than pelagic residents in the last two cruises, although the differences were not as great. Unlike the situation with juvenile pink salmon, these results cannot be attributed to growth occurring between the intertidal and pelagic sampling dates.

The sample of stomachs from pelagic chum salmon was too small to show confidently a dietary shift with movement from the nearshore to the pelagic habitat, so all juveniles were pooled to provide a single prey spectrum for this species (Fig. 33). Fifty-nine of the 72 fish in the sample were caught in the intertidal zone, and as might be expected remembering the results for pink salmon, the prey spectrum is dominated by epibenthic harpacticoid copepods. Teleostei (in only a few large juveniles), gammaridean amphipods, harpacticoids, and mysids comprised the bulk of the diet in terms of weight. Calanoids were only incidental, but this is surely due to the small number of pelagic fish in the sample.

Gosho (unpublished data from 1971) found the diurnal diet of 80 pelagic juvenile chum salmon from Alitak and Kiliuda bays to consist of copepods (0-36.3% by numbers; range for 3 samples), pelagic eggs (11.8-94,8%), zoea (1.7-3S.9%), winged insects (0-71.7%), harpacticoids (0-2.6%), fish larvae (0-4.0%), and *Oikopleura* (0-3.7%). The nighttime diet, based on 114 fish from Kiliuda Bay, was harpacticoids (23.9% by numbers), indicating nearshore or epibenthic feeding, decapod zoea (18.2%), *Oikopleura* (17.0%), winged insects (15.2%), pelagic eggs (7.2%), copepods (9.6%), pteropods (4.0%), thoracica cypris (1.6%), and fish larvae (1.0%).

Dolly Varden, *Salvelinus malma*

The life history of Dolly Varden is quite variable, but many stocks in the Gulf of Alaska area typically move out of lakes and enter estuarine waters in the spring, feed in marine waters through summer, and return to freshwater for the winter (Blackett, 1968; DeLacy and Morton, 1943). Spawning is in fall, and the young remain in freshwater for 3 or 4 years before beginning the annual anadramous behaviour of adults. Dolly Varden feed very little in winter, resulting in an 8 to 31% weight loss (data taken from Eva Creek, Baranof Island, by Heiser, 1966), although this pattern probably varies greatly with stock and local food supply. In any event, most of the growth occurs in the marine environment in spring and summer.

The length frequencies of Dolly Varden caught in the present study are presented in Fig. 34, but there are insufficient data to identify even the youngest year classes. Relying on length data from Heiser (1966), the smallest fish (around 100 mm) were probably 3 or 4 years old and newcomers to the marine environment. The largest fish may have been over ten years old.

Eighty-four stomachs from Dolly Varden collected mainly from Ugak and Alitak bays in all cruises were examined for food habits, and the resulting prey spectrum is shown in Fig. 35. Only one stomach in the entire sample was empty, and several stomachs were distended after heavy feeding on gammaridean amphipods. Larval and juvenile fish comprised most of the prey weight, and the sand lance was the principal forage species. Only five juvenile pink salmon occurred in the sample, comprising .05% of the diet in terms of numbers and .18% by weight. The other teleosts consumed were juvenile sandfish, yellow Irish Lord, herring, greenling, and great sculpin. The other principal prey taxon was Gammaridea, which swamped the other categories in terms of numbers of prey organisms. Other food items were insects, hyperiidean amphipods, polychaetes, mysids, algae, fish eggs, and, not shown in Fig. 35, juvenile Natantia, Euphausidaceans, juvenile gastropod, cumaceans, and isopods.

Roos (1959) studied the food habits of Dolly Varden from Chignik Lagoon, and also found from his sample of 188 fish that amphipods were the most frequently occurring prey items (81.1% in his sample, 23% in the present study). Simenstad, Isakson, and Nakatani (in press) found that the diet of 66 Dolly Varden from Amchitka Island consisted principally of decapods, amphipods, fish (largely sand lance), and insects, in order of decreasing frequency of occurrence.

Dolly Varden have long been thought to prey heavily on juvenile salmon (Ricker, 1941; Rounsefell, 1958; Roos, 1959; Lagler and Wright, 1962), although most studies have been concerned with predation specifically on sockeye salmon in the freshwater environment. Armstrong (1965) found that young salmon comprised 28.1% by weight and 21.6% by frequency of occurrence of the diet of Dolly Varden caught in Hanus Bay, Baranof Island. Capelin, herring, and mysids were the other principal prey items. Lagler and Wright (1962), however, found little evidence of predation by Dolly Varden on juvenile salmon in Little Port Walter estuary, Baranof Island, although their sampling took place after the peak of downstream migration of the young salmon. Little predation on young salmon was indicated in the present study as well, but again, most of the Dolly Varden were caught in midsummer after most of the salmon had moved to the epipelagic habitat.

An annotated bibliography on the Dolly Varden was prepared by Armstrong and Morton (1969).

Capelin. *Mallotus villosus*

Despite the fact that the capelin is one of the most abundant and most important forage fish in the Gulf of Alaska and Bering Sea regions, surprisingly little is known about its ecology and life history. Spawning occurs in June and July in the Bering Sea (Musienko, 1970) and in September and October in southern British Columbia (Hart, 1973). In the present study, no evidence of spawning was seen within the bays, although sexually dimorphic adults (i.e., males in breeding condition) were caught occasionally in late May and mid-June in the pelagic and intertidal zones. There is a sport fishery for capelin along the exposed sandy beaches of Kodiak Island in May and June (Jim Blackburn, personal communication), which further points to these months as the spawning season. Eggs hatch in 2 to 3 weeks, and the larvae become pelagic. Fecundity, age at maturity, growth, and life span vary considerably between different areas.

The length frequency distributions of capelin caught by the midwater . trawl are pictured in Fig. 36. Fish caught by the tow net were generally smaller than those caught by the midwater trawl, but it is impossible for us to separate effects due to gear selectivity. Large adults occurred in the trawl samples only in late May, and in beach seine samples in late May and June. Later in the summer large adults may have died after spawning, left the bays, or remained close to the bottom unavailable to our midwater trawl. The smallest fish indicated in Fig. 36 in the first cruise were probably one year old, since the vernal spawning season precludes their being young of the year. Two-year-old fish presumably comprise the second mode around 90 mm. In late July it seems that larger fish were caught, but by mid-September the mode decreased to 95-99 mm again.

The prey spectrum for pelagic capelin shows the principal food items to be euphausiids, larval fish, and calanoid copepods, although some fish may have been feeding close to the bottom to consume typically epibenthic forms such as polychaetes and harpacticoids (Fig. 37). Euphausiids and copepods were also the main items in capelin stomachs in other studies (Hart and McHugh, 1944; Barraclough, Robinson, and Fulton, 1968; Barra. clough and Fulton, 1968).

Masked greenling, *Hexagrammos octogrammus*

This species is distributed from the Sea of Japan, through the Bering Sea, and southeast along the Aleutian coast to about Sitka. Its presumed absence from Amchitka Island (Simenstad, Isakson, and Nakatani, in press) and abundance in other Aleutian areas (Wilimovsky, 1964), however, attest a discontinuous distribution over at least part of its range. Spawning occurs in the neritic zone between early summer and fall (generally earlier in more northern waters), and young of the year inhabit the epipelagic zone of the open ocean where they grow very little before returning to littoral areas the following summer.

The masked greenling was the most abundant and smallest hexagrammid species in the estuarine bays of Kodiak Island. Three distinct size classes are apparent in Fig. 38: one-year-old juveniles, presumed two-year-olds (100-170 mm), and older fish, over about 180 mm. Gorbunova (1962) presented data from Kamchatka showing 3, 4, 5, and 6-year-old females being 18.5-19.5, 22.0-26.0, 26.0-27.0, and 28.0 cm, respectively, and Rutenberg's (1962) very small sample of Unalaska fish included 3- and 4-year-old fish 23.0 and 23.8 cm long, respectively. The greatest growth of juveniles in the present study seemed to occur between the last two cruises, after they had shifted from the pelagic to the nearshore environment (Fig. 38).

The food habits of this species should be viewed from at least three ecological perspectives: pelagic and nearshore juveniles, and adults. Only seven pelagic juvenile greenling collected for stomach analysis were positively identified to *H, octogrammus*, and their food consisted overwhelmingly of calanoid copepods, with reptantian zoea and harpacticoids in lesser amounts. The diet of 12 nearshore juveniles consisted of more epibenthic prey, as expected (Fig. 39). Gammaridean amphipods and polychaetes comprised most of the diet by weight, and Gammaridea and Harpacticoida were the principal taxa in terms of numbers of organisms. Stomachs were not saved from any adults caught by the trammel nets because of the excessive digestion expected in the duration of the sets. Hence, the adult prey spectrum (Fig. 40) is based mainly on small adults caught by the seine and try net. Gammaridea was the main prey category in adult stomachs, followed by polychaetes, small shrimp and crabs, and isopods. Many other taxa of smaller organisms were also represented.

Whitespotted greenling, *Hexagrammos stelleri*

The whitespotted greenling has about the same distribution as the masked greenling, but it extends further south along the American coast to northern California (Quast and Hall, 1972). This species was also very abundant in our pelagic and especially nearshore samples in the last three cruises.

The length frequency distributions pictured in Fig. 41 are dominated by the large numbers of age-1 juveniles caught in the pelagic and nearshore zones, especially in cruise 3. Again, the greatest growth in juveniles occurred after transition to the neritic habitats. The other age-classes represented in our data cannot be distinguished.

Stomach samples were taken from mainly juvenile whitespotted greenling. Juveniles caught in the pelagic zone of Alitak Bay in late June fed predominantly on calanoids, decapod zoea, and Euphausiacea (Fig. 42), as found also for juvenile masked greenling and salmonids. Barraclough and Fulton (1968) and Barraclough, Robinson, and Fulton (1968) also found copepods to comprise over 90% of the diet of pelagic whitespotted greenling, with amphipods, decapod larvae, ostracods, cypris larvae, fish eggs, and *Oikopleura* making up the remainder.

Gosho (unpublished data) examined 255 pelagic juvenile *Hexagrammos* spp. (probably mostly *H. stelleri*) caught in early summer, 1971, in several samples from Alitak Bay. The diurnal diet consisted largely of copepodids (31.0-92.6% by numbers), pelagic eggs (up to 6.0%), zoea (1.8-81,3%), harpacticoids (1.0-1.8%), and thoracica cypris (2.1%). The nighttime diet was mainly zoea (81.3-91.3%), fish larvae (1.0%), and thoracica cypris (1.1%).

The diet of 47 nearshore juveniles also collected from Alitak Bay but about one month later was mainly harpacticoids, gammarideans, caprellideans, and calanoids (Fig. 43). Small numbers of barnacles and polychaetes also contributed significantly to the biomass consumed.

Rock greenling, *Hexagrammos lagocephalus*

This species includes two forms (*H. lagocephalus* and *H. supercilious*) which were earlier given specific status (Quast, 1960). Both forms were identified in our samples from Kodiak Island. The species has the widest distribution of all greenlings, ranging from northern China to southern California.

Figure 44 shows the length frequency distributions of rock greenling from Kodiak Island, Very few juveniles were caught in our survey, which contrasts results for the other congeneric species. This substantiates Gorbunova's (1962) view that the juveniles remain in the open ocean for 3 or 4 years before recruiting to the littoral zone. We have no explanation for the demonstrable decrease in mean size of adults throughout the summer (Fig. 44), but surmise that it may be due to larger fish moving into deeper water after completion of spawning in July-August. Simenstad (1971), however, found no evidence for adult dispersal or migration in an ecological study of rock greenling off Amchitka Island. Females attain a considerably larger size than males (Fig. 45), and length data from Gorbunova (1962) suggest that this is due to different mortality rates rather than different growth rates between sexes.

Only eight rock greenling were examined for food habits in this study since few fish were caught by gear other than the trammel nets (which are not a preferred source of stomach samples since digestion cannot be arrested immediately after capture). Most of these fish had gammarideans (comprising over 75% of the diet by weight) and caprellideans in their stomachs, and four or fewer fish had eaten pelecypods, hydrozoans, mysids, polychaetes, fish, isopods, and barnacle larvae. Simenstad (1971) studied in detail the food and feeding habits of rock greenling, and found the diet to consist of, by weight: 43.2% amphipods, 31.9% inanimate matter (mostly algae), 10.2% mysids, 6.4% molluscs, 4.5% fish, and 1.0% copepods. Klyashtorin (1962) found that the diet of only 20 rock greenling from the Kuril Islands was chiefly amphipods , with smaller quantities of isopods, polychaetes, molluscs, and fish.

Great sculpin, *Myoxocephalus polyacanthocephalus*

This species was the most abundant cottid in our nearshore survey, and comprised between 4 and 8% by weight of the total catch of fish and invertebrates in the benthic survey of Ugak and Alitak bays by ADF&G (R.U. 486). The great sculpin also occurs in great abundance on the continental shelf throughout the Gulf of Alaska region (Ronholt, Shippen, and Brown, 1976; Ronholt, personal communication). Young-of-the-year great sculpin were abundant in beach seine catches in the first two cruises, but were caught in less abundance relative to other age groups later (Fig. 46). Age-0 great sculpins were just under 60 mm by mid-September, so the fish with lengths centered at about 75 mm in cruise 1 were surely one- and, perhaps to some extent, two-year olds. Most of the larger fish pictured in Fig. 46 were caught by the try net and trammel nets in subtidal habitats.

Hart (1973) briefly described the great sculpin as a piscivore, but our samples and other studies suggest a considerably more diverse diet. Fish were the principal prey organisms in our sample in *terms of* weight

(Fig. 47), and were consumed by juveniles and adults. The category Scorpaeniformes was represented by one fish in the stomach of a large sculpin. Juvenile sand lance were the most numerous fish in the stomach contents. Majiid crabs were also an important prey category by weight. Gammaridean amphipods contributed very little to total consumed biomass, yet were the most frequently occurring prey items. Prey represented in small quantities were nematods (possibly parasites), corophiids, caprellideans, shrimp, echinoids, pelecypods, flabelliferan isopods, algae, and polychaetes. Simenstad, Isakson, and Nakatani (in press) found about 100 crabs in the stomachs of only four offshore great sculpins, while the diet of nearshore fish was mainly amphipods and isopods with smaller quantities of fish and gastropod.

Snake prickleback, *Lumpenus sagitta*

The snake prickleback was the most abundant blennioid fish in our survey, represented by large numbers of postlarvae and small juveniles in the pelagic zone and by larger juveniles and adults in nearshore (particularly try net.) samples. Figure 48 provides length frequency information and shows the overall decline in adult abundance in the catches of later summer. The prey spectrum for 41 nearshore juveniles and adults is shown in Fig. 49. Gammarideans and harpacticoids were the main items, although polychaetes also contributed considerably to the diet in terms of weight. Barraclough, Robinson, and Fulton (1968) found copepods to be the principal food of young-of-the-year pricklebacks inhabiting the pelagic zone near Vancouver Island.

Pacific sandfish, *Trichodon trichodon*

Age-O sandfish were second only to capelin in abundance in our pelagic samples. The species is distributed from Kamchatka, through the Bering Sea, to California (Quast and Hall, 1972), although there are major discontinuities in its range. No postlarval sandfish were reported in the extensive pelagic sampling in the Strait of Georgia (Barraclough, Robinson, and Fulton, 1968), yet there is an adult population along both coasts of Vancouver Island (Hart, 1973). Ronholt, Shippen, and Brown (1976) found adult sandfish in the Gulf of Alaska in 9.1% of the bottom trawls between 1 and 100 m and in 2.5% of the trawls between 101 and 200 m. Sandfish spawn in late winter and early spring.

The growth of the age-O cohort is clearly illustrated in Fig. 50. The largest fish caught was 190 mm, but adults can attain 305 mm (Clemens and Wilby, 1961).

Sixteen juvenile sandfish were examined for food habits, and crab zoea and larval fish comprised the bulk of their diet by weight (Fig. 51).

Pacific sand lance, *Ammodytes hexapterus*

The Pacific sand lance has a complex life history, inhabiting pelagic, benthic, and nearshore habitats in various times of the year. The length frequency distributions shown in Fig. 52 are misleading, because we did not measure many postlarvae in the first two cruises. Postlarval catches were large in those cruises, but decreased later in the summer as the small juveniles recruited to the nearshore zone. Barraclough, Robinson, and Fulton (1968) also found a decrease in epipelagic larval sand lance catches in the early summer. The dominant size class shown in Fig. 52 was probably made up of mainly one-year-old fish, which supports Andriyashev's (1954) statement that catches of sand lance in the nearshore zone are mainly of the second age group (1+). Although Andriyashev's data was for the closely related European form, which he called *A. h. marinus*, the life histories of the Barents Sea and north Pacific forms are probably very similar. The Barents Sea form lives to four years, and allegedly matures in the third year. According to Andriyashev, juveniles and adults move to shallower water in the spring and early summer, and presumably the younger age groups move closer to shore than large adults. In the late summer and fall they return to deeper water. Spawning is in late winter.

The prey spectrum of 86 juvenile and adult sand lance caught in the intertidal zone is pictured in Fig. 53. Primarily pelagic organisms such as calanoids (contributing about 75% of the biomass), zoea, larvaceans, and nauplii were the principal food items, which is surprising considering where the samples were taken. Andriyashev (1954) mentioned that the food of *A. h. marinus* from the Barents Sea is mainly planktonic crustaceans such as calanoids, barnacle larvae, and euphausiids, rather than benthic or epibenthic organisms as might be expected. Further, Simenstad, Isakson, and Nakatani (in press) also showed a high incidence of copepods in sand lance caught off Amchitka Island, and suggested that this species may transfer a significant amount of trophic energy from the pelagic to nearshore areas.

Rock sole, *Lepidopsetta bilineata*

The rock sole is one of the principal flatfish species in the shallower waters of the entire Gulf of Alaska region, and particularly in the area around the Alaska Peninsula (Alverson, Pruter, and Ronholt, 1964; Best, 1969a,b, 1.974; Int. Pac. Halibut Comm., unpublished data). It was the most abundant flatfish in our nearshore samples from Kodiak Island.

Almost all of the rock sole caught in this study were measured. Young of the year were caught in the latter half of the summer, and a large recruitment of age-O fish to the nearshore zone was apparent in the last cruise (Fig, 54). The dominant size class indicated consists of 1-, 2-, and perhaps some 3-year-old fish, based on age/length information from Musienko (1957) collected in the Bering Sea and from Forrester and Thomson (1969) collected in Hecate Strait. An abundant cohort of fish around 260 mm (probably 4-year-olds) is indicated by our data, but this may be due to try net size-selectivity (most of the fish over about 150 mm were caught by the try net). Very few fish over about 340 mm were caught in this study (Fig. 54). Applying age/length information from Forrester and Thomson (1969) and Chitton and Smith (1971), this size corresponds to 5- to 7-year-old fish, depending on sex. Since the youngest age at maturity is about 4 years (Forrester, 1969) it is clear that there are few mature fish in the extreme nearshore zone of the estuarine bays around Kodiak.

The food of 114 juvenile and adult rock sole collected mainly from Ugak Bay in the last three cruises was largely sand lance by weight, but amphipods, polychaetes, and bivalves in terms of numbers and frequency of 'occurrence (Fig. 55). The bivalves and sand lance were consumed almost only by adult rock sole. Other items included algae, cumaceans, mysids, isopods, and fish eggs. Shubnikov and Lisovenko (1964) described the diet of Bering Sea rock sole as 62% polychaetes, 37% molluscs, and 13% crustaceans (mostly Natantia). Simenstad, Isakson, and Nakatani (in press) examined 20 rock sole from the offshore sand and gravel community around Amchitka Island and found amphipods, ophiuroids, cumaceans, hermit crabs, *Oikopleura*, gastropod, and bivalves to be the most frequently occurring prey items. Forrester (1969) mentioned that rock sole eat mostly polychaetes and at larger sizes mostly fish, of which sand lance is the most important.

Yellowfin sole, *Limanda aspera*

This species and the rock sole comprise the especially abundant flatfishes in the nearshore zones of the estuarine bays around Kodiak Island. The yellowfin sole was generally more abundant than the rock sole in our try net catches, but was almost completely absent from the intertidal zone. Yellowfin sole abundance increased toward the deeper subtidal zone, although this trend was only demonstrable and unoccluded by sampling variability in Ugak Bay where the highest catches occurred (Table 3).

The length frequency diagrams for yellowfin sole also show a recruitment of young of the year by late summer (Fig. 56), as found for the rock sole. Large adults were caught almost only in midsummer, and only small numbers of fish over about 200 mm were encountered in the last cruise. This may be due to offshore movement by larger fish toward the end of summer. According to age/length data summarized by Kitano (1969), most cf the fish in our samples (i.e., less than about 240 mm) were about 5 years old or younger. Moiseev (1953) reported that yellowfin sole in Peter the Great Bay mature in the third or fourth year (20-23 cm), and Fadeev (1963) showed a wider variation of age at maturation for Bering Sea fish: 4-7 years (14-28 cm) for males and 5-10 years (19-36 cm) for females. If these maturity data can be roughly applied to our length frequency results, it seems evident that most of the nearshore fish are immature.

The food habits of yellowfin sole are pictured in Fig. 57. Small bivalves were the most frequently occurring items, but they contributed relatively little to the total consumed biomass. Fish (mostly sand lance) and echiuroids comprised most of the weight of prey, and were eaten almost exclusively by a few adult sole. An analysis of 548 yellowfin sole from offshore waters in the southeastern Bering Sea by Skalkin (1963) showed the diet to consist mainly of gammaridean and hyperiidean amphipods, mysids, euphausiids, small bivalves, ascidians, echiuroids, and pandalid shrimp. There were notable differences in diet between area and depth in that study.

Other Species

Basic statistics on length distributions (pooled over all bays, cruises, and gear types) for all other species caught in this study are presented in Table 4. Also, the prey spectra for four of these are provided without comment: coho salmon, Fig. 58; Pacific cod, Fig. 59; starry flounder, Fig. 60; sand sole, Fig. 61.

Physical Data

Mean pelagic surface temperatures are presented in Table 5. To some extent the means and standard deviations reflect the fact that three types of thermometers were used at different times during field work. The surface waters of Alitak and Kaiugnak bays warmed -to about 11°C by late July and cooled about 1°C by mid-September. The late-June mean for Ugak Bay is quite high, and is surely due to the week of very warm and calm weather that followed pelagic sampling of the other bays and immediately preceded townetting in Ugak Bay. Ugak Bay surface temperatures also fell slightly by early September.

Midwater temperatures are tabulated by bay, cruise, and depth stratum in Table 6. All data for the last two cruises were taken by the Beckman salinometer, and are presumed reliable despite the few suspiciously high temperatures at depth. The deepest strata of Alitak Bay were generally colder than the same strata in the other bays, probably because Alitak Bay is a true fjord (i.e., the Deadman Bay region is much deeper than the mouth of Alitak Bay, and serves as a sink for cold water).

As in the epipelagic zone, temperatures in the nearshore zone rose in all bays to about 11.4°C by late July/early August, and dropped about 1*C in the last cruise (Table 7).

Salinities were also measured by more than one technique; all nearshore values are based on lab analysis of bottled samples and most pelagic salinities were read in the field from the Beckman salinometer (Table 8). The nearshore salinities were lowest, which would be expected since many of our beach seine sites were close to river mouths. There was considerable variation of epipelagic salinity readings, probably reflecting various degrees of mixing of fresh and salt waters with particular weather and sea states. The surface salinities were always slightly less than the midwater salinities.

Deposition of Data

All data collected in this project have been properly coded, formatted (EDS File Type 023), placed on 7-track magnetic tape, and sent to EDS/NODC with full documentation as part of the OCSEAP data base.

INTERPRETATIONS RELEVANT TO OIL DEVELOPMENT

While it is not an objective of this study to assess or predict the impact of petroleum resource development on the estuarine fish fauna of Kodiak Island, some of our results have direct bearing on the matter, There are numerous potential impacts of resource development of the outer continental shelf but this discussion will pertain only to the most obvious: direct spillage of oil or refined products into the marine environment.

The epipelagic and nearshore zones are perhaps the most critical estuarine habitats regarding oil pollution as they would probably receive the most immediate and direct effects. In the event of a spill or well blow-out, oil will remain on the surface for a period leaching toxins into the epipelagic zone. Depending on currents and wind, it would eventually drift inshore. The principal epipelagic inhabitants are juvenile salmonids, greenling, capelin, and sandfish. Salmonids should be of particular concern because of their economic importance and because they are strictly surface-dwelling fish. They might easily avoid a mass of oil floating into a bay, but in so doing they would perhaps leave the bay prematurely or move to another, inferior part of the bay. Many nearshore fishes might also easily avoid an inshore drift of contaminants but their ultimate fate would then depend on their success as refugees. Stationary or territorial fishes such as spawning greenling, homing salmon bound for a particular stream mouth, and littoral fishes with definite home ranges (Gibson, 1967) would be disadvantaged.

Spawning and juvenile rearing are two important uses of estuaries which warrant discussion. If juvenile fish are especially susceptible to the inimical effects of petroleum hydrocarbons, as suggested by Nelson-Smith (1972), Struhsaker (1977), and Evans and Rice (1974), the use of estuarine bays as nursery or rearing areas by numerous species takes on special importance. Our pelagic catches were mainly juveniles of capelin, sandfish, sand lance, salmonids, greenling, bathymasterids, stichaeids, herring, scorpaenids, and cottids. Larvae of some of these forms were also caught in large numbers, but the peak of larval abundance is probably in spring as in other north Pacific waters. Nearshore catches were principally juveniles of salmon, sand lance, greenling, cottids, flatfishes, herring and capelin. Postlarval and juvenile fish of many species recruit to nearshore habitats from the pelagic zone during spring and summer, Among these are sand lance, greenling, cottids, flatfishes, and most intertidal fish. Others, including herring, capelin, and salmonids, live as juveniles in the nearshore zone and move to pelagic waters by the end of summer.

Fish are most sensitive to oil pollution during periods of physiological stress, such as during spawning. Spawning fish are not only affected themselves, but hydrocarbons incorporated into their gonadal products can reduce gametic, embryonic, and larval survival (Struhsaker, 1977). In this regard, critical estuarine species would include those which spawn en masse in the nearshore zone, such as herring, capelin, greenling, and salmon. Salmon spawn mostly in freshwater, of course, but pink and chum salmon spawn to some extent in intertidal areas at the mouths of streams. Most other species that spawn in part in the estuaries do so in the winter and early spring. These include flatfishes, gadids, cottids, rockfishes, and blennioid fishes.

Oil will have direct effects on fishes of all life history stages, but also indirect effects through depletion of prey populations or through ingestion of toxins incorporated into prey organisms. This study identified some of the major prey groups that should be considered in this regard. Most of the pelagic fishes examined relied heavily on calanoid copepods (nauplii, copepodids, and adults), decapod zoea, barnacle cypris, and pelagic eggs. Larger plankters such as euphausiids, hyperidean amphipods, and fish larvae were also important prey. We did not catch enough large fish in the pelagic zone to determine the incidence of predation on juvenile capelin, salmon, sandfish, and sand lance. Nearshore fish consumed a large array of epibenthic and benthic prey including harpacticoid copepods, gammaridean amphipods, settled cypris, juvenile gastropod and pelecypods, polychaetes, and various life history stages of shrimp and crabs. The sand lance was the most important nearshore forage fish.

RECOMMENDATIONS FOR FURTHER RESEARCH

More baseline information is needed before the estuarine bays of Kodiak Island are sufficiently understood to permit assessment of the potential impact of offshore oil development. Additional work would stem largely from two needs: 1) to use a wide assortment of gear to sample fish of all life history stages, and 2) to sample over a larger time frame.

The present study employed five types of gear but nevertheless large adults and especially larval fish were probably not caught in proportion to their true abundance in the bays. Further study should employ smaller gear, perhaps Bongo nets, to sample larval and juvenile fish in nearshore and pelagic habitats, and larger gear, perhaps longlines and/or purse seines, to sample adult pelagic fish. The trammel nets were found to be effective for a wide range of fish size and morphology, but in the present study limitations of field time permitted their use only in areas unworkable by the try net. Ideally, trammel nets would be fished in all nearshore habitats to reflect the abundance of adult fish in the entire nearshore zone.

Larval fish should be given special consideration in a baseline assessment as they comprise a major fraction of the estuarine fauna. A large effort should first be placed on larval identification. This would include preparation of a reference collection containing series of larval stages of as many species as possible. Larval fish should be sampled systematically and quantitatively to provide information on seasonality, distribution (geographic and vertical), relative abundance and development.

At least three temporal aspects of fish ecology must be considered in baseline work: annual, seasonal, and diel. This project covered only one season in one year, and it certainly should not be used as the sole indication of the Kodiak nearshore and pelagic estuarine fish fauna. There are often major year-to-year variations in marine communities, and consequently sampling should occur over at least two years and preferably more.

Sampling should also be done in all seasons of the year, although inclement weather conditions would make year-round sampling difficult and would perhaps result in major data gaps. The present data give little information about the estuarine fish communities of fall, winter, and spring. Major faunal changes were identified in the summertime sampling of the present study, but equally important changes probably take place in other seasons as well. Many fish might move into deeper water or completely out of the bays with the onset of winter, thus greatly changing the species composition of the nearshore zone. Also, sampling in winter and spring would be required to determine which species spawn in the bays at that time. This information would be correlated with the results of the vernal larval sampling to give a fairly complete picture of reproduction and early life history of most species in the bays. Seasonal changes in food and feeding habits should also be monitored.

There are often dramatic diel changes in the species composition of marine communities resulting from vertical migrations or on- and offshore movements. Several cases of diel movements were evinced in this study, but limitations of field time precluded more nighttime sampling. Subsequent study should include considerable nighttime work to identify the species making major diel movements and the combined effects of these movements on the species composition in various habitats.

Lastly, some effort should be made to determine the uniqueness of the estuarine fish fauna. This would include a small sampling effort in pelagic and nearshore habitats just outside the mouths of the bays and off the outer coast between bays. This approach would perhaps indicate a gradation from estuarine to oceanic fish communities, and would help to identify further critical species, life history stages, and ecological relationships which are typically if not strictly estuarine.

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Table 1. The sampling effort, in terms of number of standard hauls, applied in each bay and cruise by gear type. The actual number of sets, when different, is in parentheses

Cruise	Gear	Ugak Bay	Kaiugnak Bay	Alitak Bay	Gear total
1	Surface trawl[1]	16	5	10 (9)	31 (30)
	Mid-water trawl	9.5 (8)	5	13 (11)	27.5 (24)
	Beach seine	16	9	8	33
2	Tow net	20	10	26	56
	Beach seine	14	6	14	34
	Try net	26	9	21	56
	Trammel net	8 (3)	2 (1)	6 (4)	16 (8)
3	Tow net	20	10	29	59
	Mid-water trawl	23	7	21 (18)	51 (48)
	Beach seine	14	7	16	37
	Try net	15	8	19	42
	Trammel net	3 (2)	2	4	9 (8)
4	Tow net	20	10	36	66
	Mid-water trawl	19	7	18	44
	Beach seine	13	9	21	43
	Try net	20	12	21	53
	Trammel net	4	3 (2)	7 (6)	14 (12)

[1]The midwater herring trawl was used on the surface in Cruise 1, and those catches' were analyzed separately from the regular mid-water samples.

Table 2. Depth distribution of principal midwater species as determined by diurnal midwater trawling. Values are mean catch per unit of effort (mean number of fish/ haul) in each stratum. NS = Not sampled

Cruise (dates)	Species	Depth strata 9-20m	21-60m	61-100m	>100m
A: Ugak Bay					
1 (5/25-5/26)	Capelin	26.4	14.8	NS	Not applicable
	Sand lance	60.8	6.6	NS	
3 (7/18-7/21)	Capelin	54.6	75*7	109,0	
	Sandfish	16.0	40'9	85.3	
	Sand lance	0	3.6	0	
4 (8/29-9/2)	Capelin	42.8	398.6	709.0	
	Sandfish	775.9	228.6	1517.3	
B: Kaiugnak Bay					
1 (5/27)	Capelin	0	0	2.0	NS
	Sand lance	33.0	18.0	0	NS
3 (7/25)	Capelin	0	138.3	3.0	NS
	Sandfish	0*5	1.7	0.5	NS
4 (9/5)	Capelin	0	0	767.0	208.0
	Sandfish	0	16.0	169.0	377.0
C. Alitak Bay					
1 (5/28-5/30)	Capelin	0	638.4	549*7	213.5
	Sand lance	0	0	,7	0
	Alaska eelpout	0	0	0	1.0
3 (7/29-7/31)	Capelin	33,3	3254.3	52.3	101.0
	Alaska eelpout	0	0	.7	17.0
4 (9/8-9/12)	Capelin	0	94.2	492.3	1593,0
	Alaska eelpout	0	0	0	10.7
	Sandfish	0	20,2	0.3	0
	Sandlance	0	10.7	0	0

Table 3. Depth distribution of rock sole and yellowfin sole in Ugak Bay as determined by nearshore trawling with a try net. Values are mean catch per unit of effort (mean number of fish/haul)

Cruise (dates)	Species	Depth of haul 4 m	9 m	13 m
2 (6/19-6/21)	Yellowfin sole	1.3	1.5	12.7
	Rock sole	6.3	7.5	6.3
3 (7/18-7/22, 8/2)	Yellowfin sole	6,8	13,3	67.5
	Rock sole	26.6	3.5	3.5
4 (8/29-9/2)	Yellowfin sole	14*7	14.6	29.5
	Rock sole	15.4	13.1	6.8

Table 4. Lengths of incidental species, all bays, cruises, and gear types combined

Species	Mean total length, mm	Range, mm	Standard deviation, mm	Sample size
Raj idae				
R. binoculata	520 (to tip of pelvic fins)			1
Salmonidae				
o* *kisutch*	188.8	35 - 734	143.57	111
O. nerka				
Juveniles	118,8	59-187	26,74	41
Adults	633.6	557-671	45.93	5
Osmeridae				
H. pretiosus				
Juveniles	66.6	52-104	11.87	26
Adult s	179,5	163-197	91,20	16
Gadidae				
G. macrocephalus	167.9	48-258	57'93	59
M, proximus	270,5	261-280	13.44	2
T. chalcogramma	85.3	35-206	41.99	44
Zoarcidae				
B. pusillum	153.2	95-185	19*99	54
Gasterosteidae				
G. *aculeatus*	47.3	21-92	26,2	72
Aulorhynchus flavidus	72			1
Scorpaenidae				
S. melanops	90,8	39-281	65.65	29
S. *nigrocinctus*	57			1
Hexagrammidae				
H. decagrammus	350.2	172-447	99.73	6
O. *elongatus*	91.0	87-95	5.66	2
P. *monopterygius*	265			1
Cottidae				
A, fenestralis	75.0	27-112	20.33	19
B. *cirrhosus*	66.1	18-185	24.15	220
B, *bilobus*	134.6	101-215	35.36	8
Gymnocanthus spp.	107.8	20-275	49.04	266
E. bison	94.4	52-169	16.03	7
E. diceraus	118.0	86-150	45.26	2
H. hemilepidotus	310.0	150-362	89,98	5
H. *jordani*	93.8	27-277	54.21	85
L, *armatus*	210.8	41-398	68.39	74

Table 4. Lengths of incidental species, all bays, cruises, and gear types ccmbined - Continued

Species	Mean total length, mm	Range, mm	Standard deviation, mm	Sample size
Cottidae - Continued				
N. *pribilovius*	64			1
P. quadrifilis	53.5	40-67	19.09	2
P. paradoxus	48			1
S. gilli	37			1
H. bolini	78			1
M. jaok	132.8	83-409	67.93	27
M. scorpius	273.3	109-467	93.53	63
T. pingeli	70.5	38-170	30.72	19
Agonidae				
P. barbata	81,0	28-183	25,51	160
A. acipenserinus	179.1	26-285	94.03	125
A. bartoni	67			1
O. dodecaedron	10008	61-127	28,08	4
Cyclopteridae				
A. ventricosus	200			1
L. cyclopus	47.5	43-52	6.36	2
Bathymasteridae				
B. caeruleofasciatus	181.3	78-231	69,80	4
B. signatus	79*7	72-90	9.29	3
Stichaeidae				
L. medius	65.4	49-120	30.58	5
C. polyactocephalus	240			1
A. purpurescens	107 .0	106-108	1,41	2
S. punctatus	107.4	91-116	9.61	5
Pholidae				
P. laeta	129.9	47-202	32.34	126
Apodichthys flavidus	32?4			1
Anarhichadidae				
A. orientalism	94			1
Zaproridae				
Z. silenus	113.6	59-163	37.45	8
Pleuronectidae				
H. elassodon	130.3	37-297	56.24	39
H. stenolepis	113.9	50-1015	144.38	57
I. isolepis	192.8	107-343	56.48	35
P. quadrituberculatus	282,0	179-385	145.66	2
P. melanostictus	192.4	42-507	100.68	98
P. stellatus	215.0	32-553	102.81	155

Table 5. Mean pelagic surface temperatures (°C) by cruise and bay, with standard deviation and sample sizes

Cruise (dates)	Ugak Bay	Kaiugnak Bay	Alitak Bay	Cruise mean
1 (5/21-6/3)	No information	No information	$\bar{T}$ = 5.3 S.D. = 1.209 n = 17	5.3
2 (6/16 -6/30)	$\bar{T}$ = 12,5 S.D. = 0.924 n = 18	$\bar{T}$ = 8.9 S.D. = 0,564 n = 9	$\bar{T}$ = 9,3 S.D. = 1,154 n = 22	10*4
3 (7/15-8/7)	$\bar{T}$ = 10.3 S.D. = 1.013 n = 29	$\bar{T}$ = 11,4 S.D. = 0.180 n = 17	$\bar{T}$ = 10.6 S.D. = 0.747 n = 37	10,7
4 (8/25 -9/16)	$\bar{T}$ = 9.7 S.D. = 0.529 n = 38	$\bar{T}$ = 10.4 S.D. = 0.508 n = 17	$\bar{T}$ = 10,1 S.D. = 0.281 n = 53	10.0
Bay m cans	10*5	10.5	10* 1[1]	

[1] The mean for Alitak Bay is based on the last three cruises only, for comparability with other bays.

Table 6. Mean midwater temperatures (°C) by depth, cruise, and bay

Cruise 1 (5/21-6/3):

No information available for Ugak and Kaiugnak bays

Alitak Bay[1]		
Depth, m	$\bar{T}$	n
31-50	2.9	1
51-70	3.1	1
71-90	2.6	1
91-110	2.2	1
131-150	3*4	1

Cruise 2 (6/16-6/30): No midwater trawling

Cruise 3 (7/15-8/7):

Ugak Bay			Kaiugnak Bay			Alitak Bay		
Depth, m	$\bar{T}$	n	Depth, m	$\bar{T}$	n	Depth, m	$\bar{T}$	n
9	7.8	1	9	10.6	1	9	9,6	1
14-30	7.2	8	14-30	1043	2	14-30	9.9	2
31-50	5,1	2	51-70	7,5	1	31-50	6.9	4
51-70	6.1	1	91-110	5.7	1	51-70	5,3	1
71-90	7.0	1				91-110	2.4	1

Cruise 4 (8/25-9/16):

Ugak Bay			Kaiugnak Bay			Alitak Bay		
Depth, m	$\bar{T}$	n	Depth, m	$\bar{T}$	n	Depth, m	$\bar{T}$	n
9	9.1	2	9	10.1	1	9	10.0	2
14-30	8.4	5	14-30	9*9	2	14-30	9.8	5
51-70	8.4	2	31-50	7.6	1	31-50	9*3	5
71-90	7.8	1	51-70	6.5	1	51-70	6.9	1
			91-110	6.5	2	91-110	3.2	3
						111-130	2.4	1

[1] Alitak Bay, Cruise 1 temperatures are possibly inaccurate because of problems with the bathythermograph slides.

Table 7. Mean nearshore surface temperatures (°C) by cruise . and bay, with standard deviations and sample sizes

Cruise (dates)	Ugak Bay	Kaiugnak Bay	Alitak Bay	Cruise means
1 (5/21-6/3)	$\bar{T}$ = 7.4 S.D. = 0.850 n = 13	$\bar{T}$ = 7,0 S.D. = 1.061 n = 9	$\bar{T}$ = 7.0 S.D. = 0,716 n = 5	7.2
2 (6/16-6/30)	$\bar{T}$ = 7.8 S.D. = 1,235 n = 40	$\bar{T}$ = 9.2 S.D. = 10759 n = 13	$\bar{T}$ = 10.2 S.D. = 1.618 n = 33	8.9
3 (7/15-8/7)	$\bar{T}$ = 11.5 S.D. = 1.592 n = 21	$\bar{T}$ = 12.2 S.D. = 0.269 n = 11	$\bar{T}$ = 10.9 S.D. = 0.990 n = 26	11.4
4 (8/25-9/16)	$\bar{T}$ = 9.6 S.D. = 1.222 n = 32	$\bar{T}$ = 11.6 S.D. = 0,769 n = 16	$\bar{T}$ = 10.1 S.D. = 0.623 n = 40	10.2
Bay means	9*0	10.3	10.2	

Table 8, Mean nearshore and pelagic salinities (parts per thousand) by bay (initialed) and cruise number

Bay/cruise	Habitat	Mean salinity (°/00)	Range	Sample size
U 1	Nearshore	19.6	0.6 - 30.5	5
U 2	Nearshore	12.3	1.3 - 32,1	8
U 2	Surface	12.8	1*7 - 27.9	3
U 3	Nearshore	17.6	7.2 - 24.3	3
U 3	Midwater	33.2	31.0 - 35.8	12
U 3	Midwater	32.9[1]	31.0 - 33.6	11
U 4	Surface	24.0	10.4 - 30,6	16
U 4	Midwater	32.8	28.9 - 33.6	11
K 2	Nearshore	29.2	26.3 - 32.0	2
K 3	Nearshore	27.9	27.0 -'29.3	3
K 3	Midwater	33,1	32.4 - 33.6	4
K 4	Surface	29,9	29,1 - 30.6	10
K 4	Midwater	33,6	33.0 - 34.3	7
A 1	Nearshore	21.0	11.3 - 30.6	2
A 1	Surface	29,7	27.7 - 32.0	3
A 2	Nearshore	30.0	26.0 - 31.8	7
A 2	Surface	31,4		1
A 3	Nearshore	31.5		1
A 3	Surface	31.7	26.2 - 33.0	27
A 3	Midwater	33.1	32.6 - 33.7	9
A 4	Surface	32.4	30.7 - 32.9	35
A 4	Midwater	33.3	31.1 - 34.7	17

[1]Excluding the suspiciously high value of 35.8°/oo immediately above,

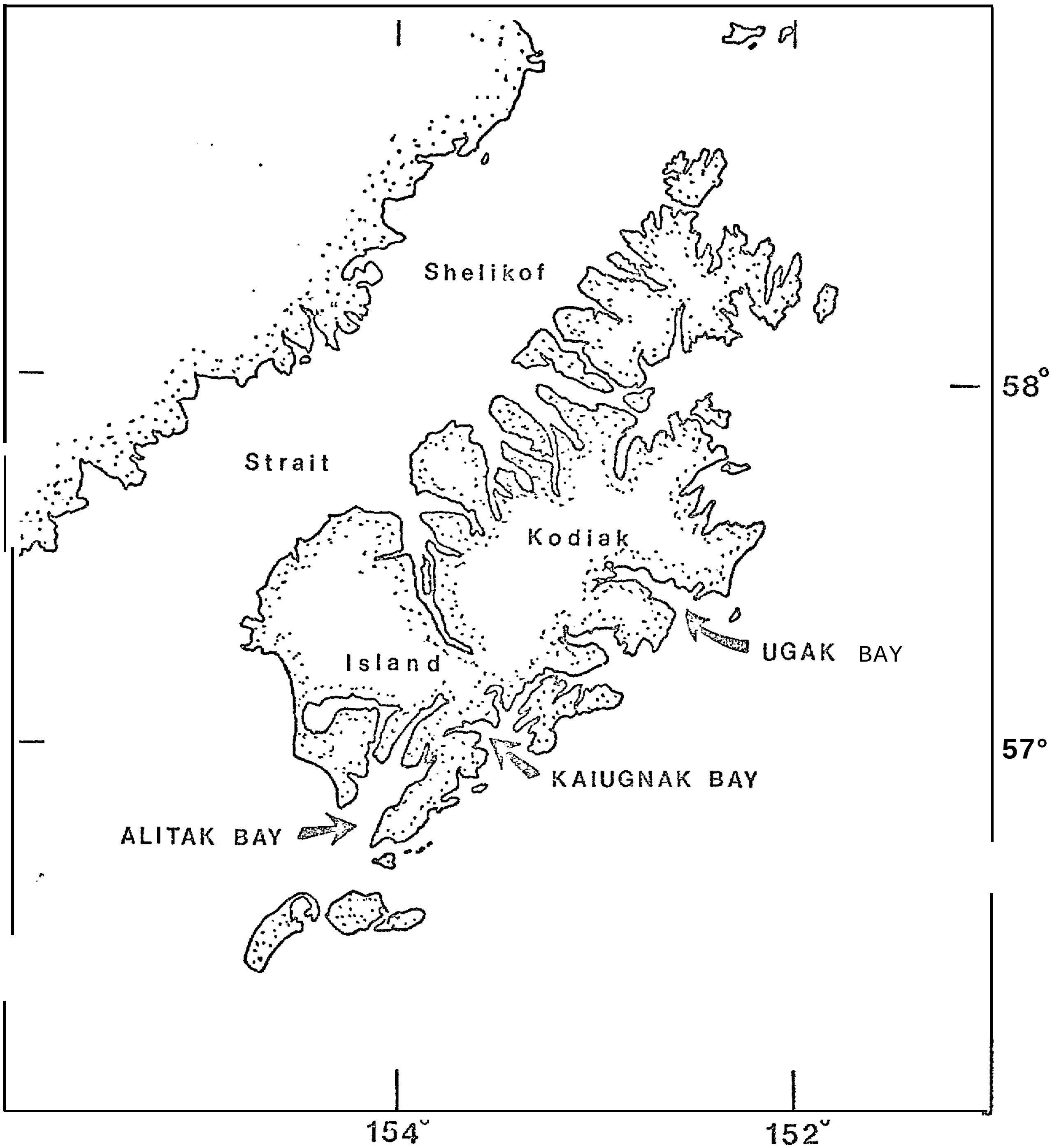


Fig. 1. Base map showing Kodiak Island and location of study bays.

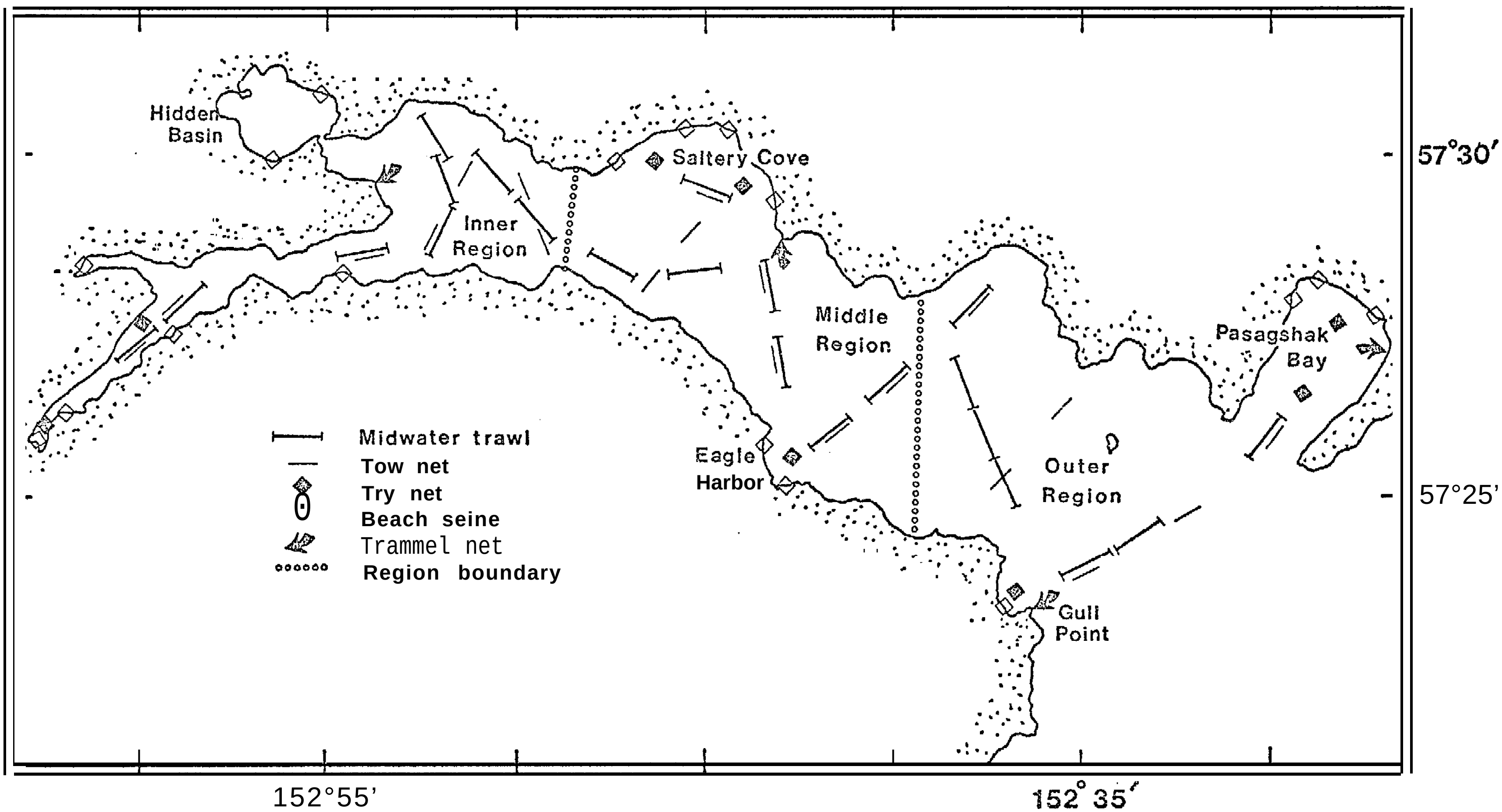


Fig. 2. Location of sampling sites and transects in Ugak Bay. Not all sites were sampled in each cruise.

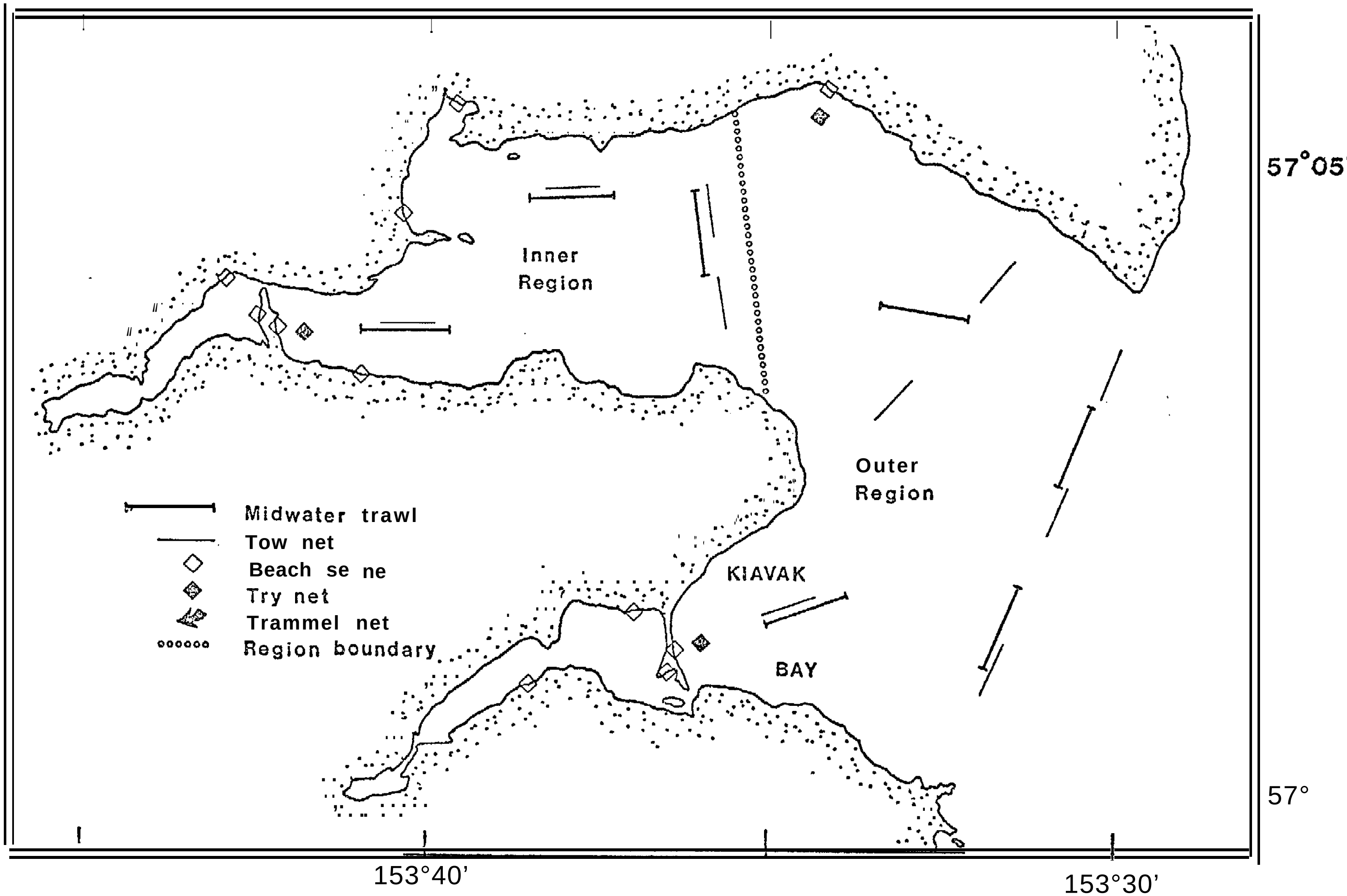


Fig. 3. Location of sampling sites and transects in Kaiugnak Bay. Not all sites were sampled in each cruise.

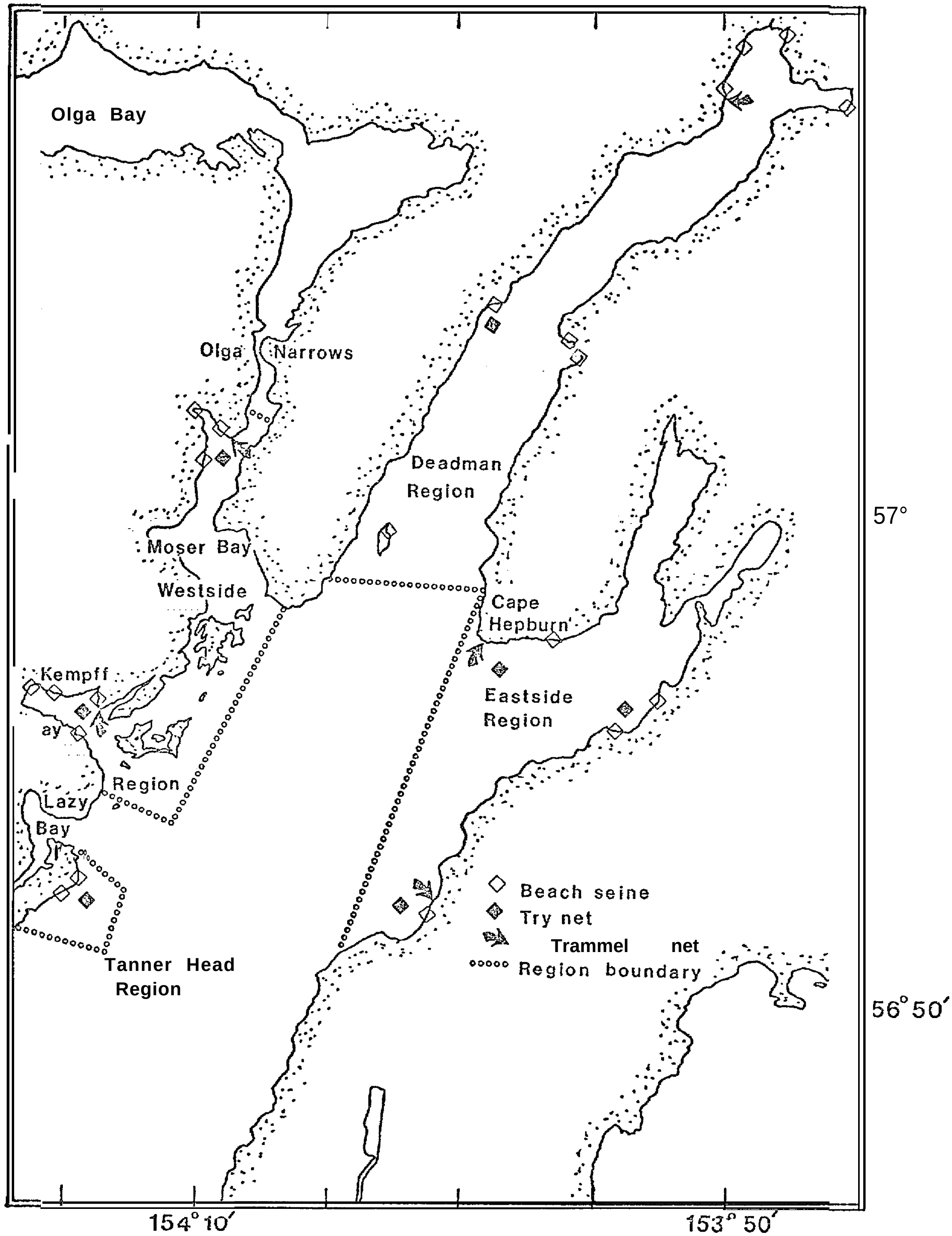


Fig. 4, Location of nearshore sampling sites in Alitak Bay, Not all sites were sampled in each cruise.

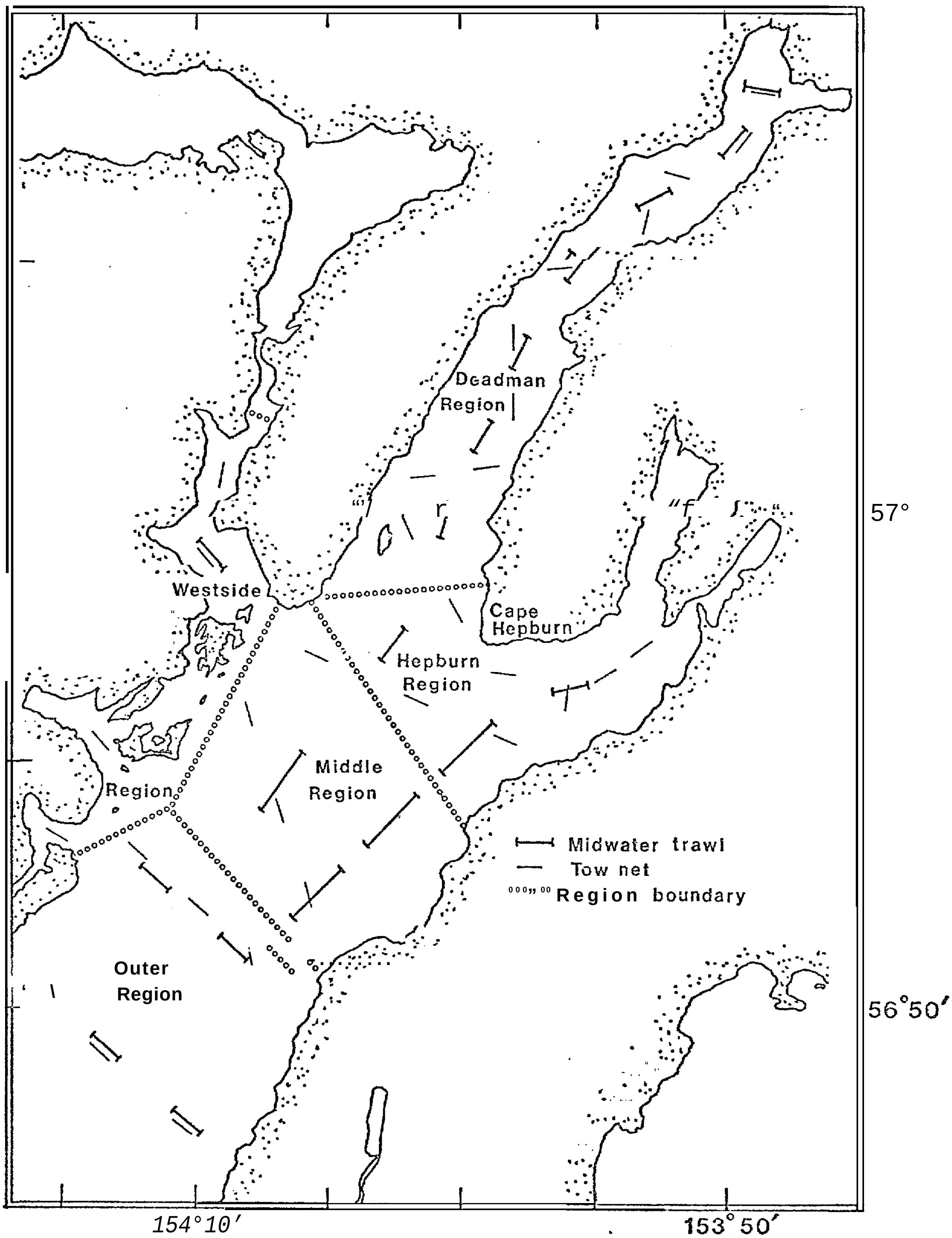
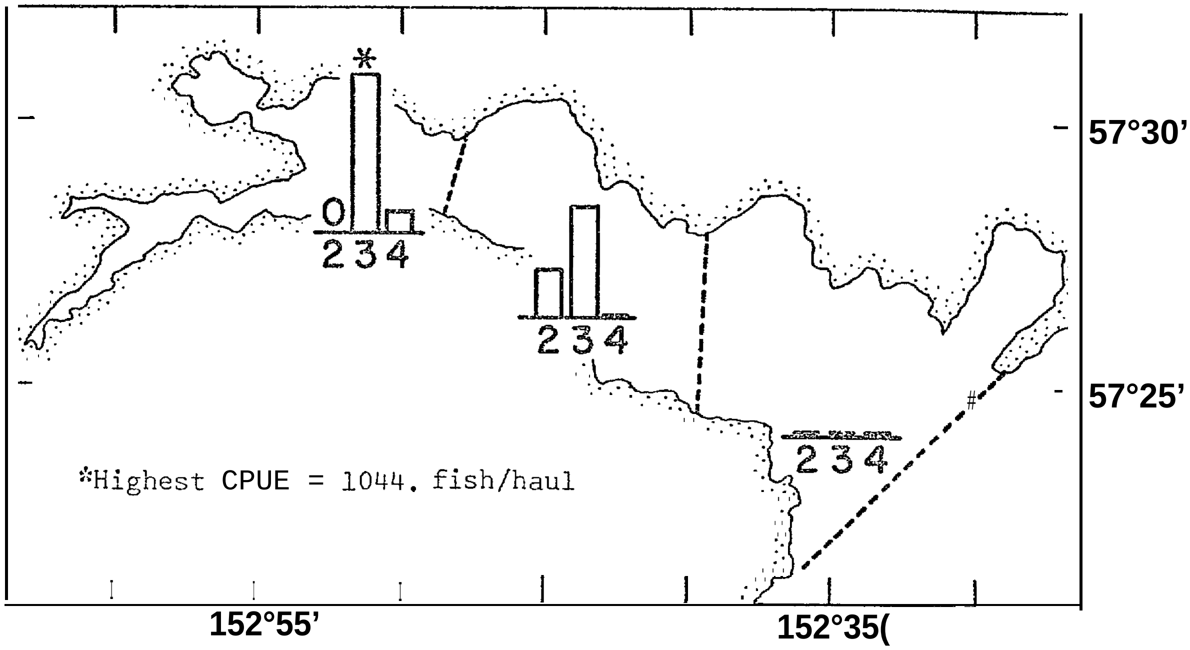


Fig. 5. Location of pelagic sampling sites and transects in Alitak Bay. Not all sites were sampled in each cruise.



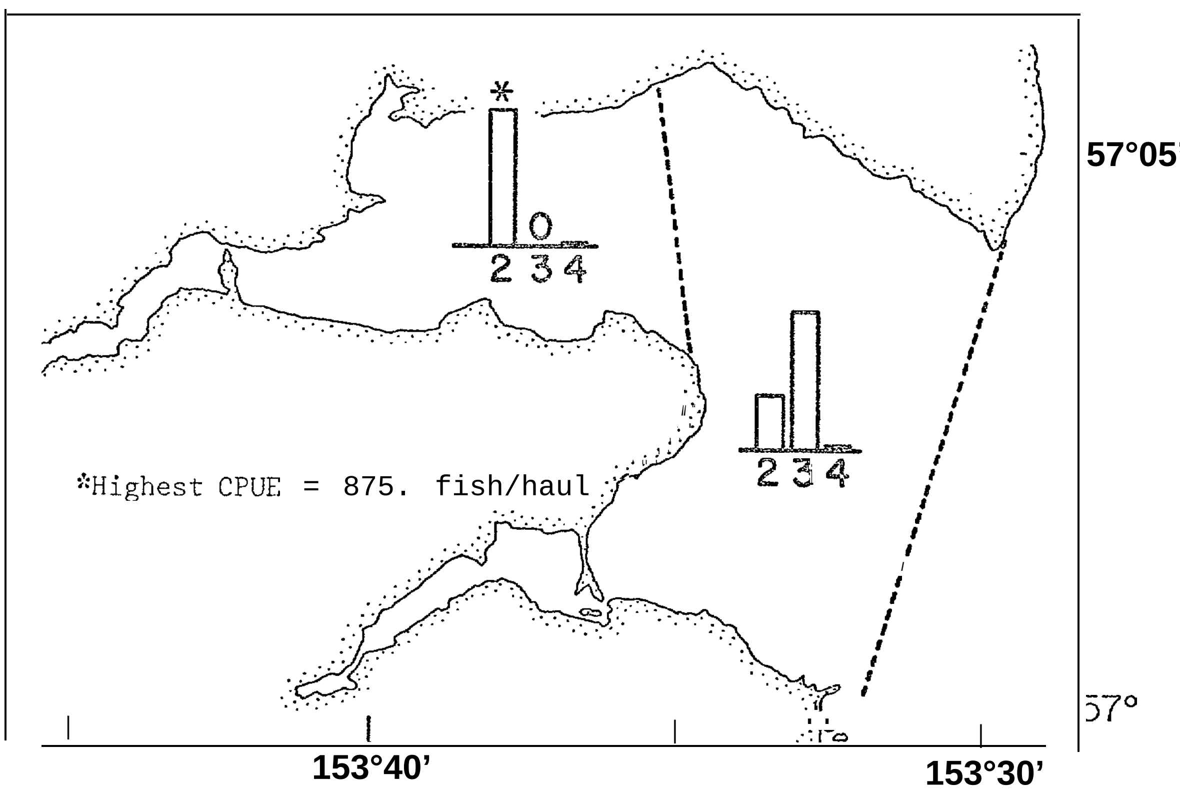
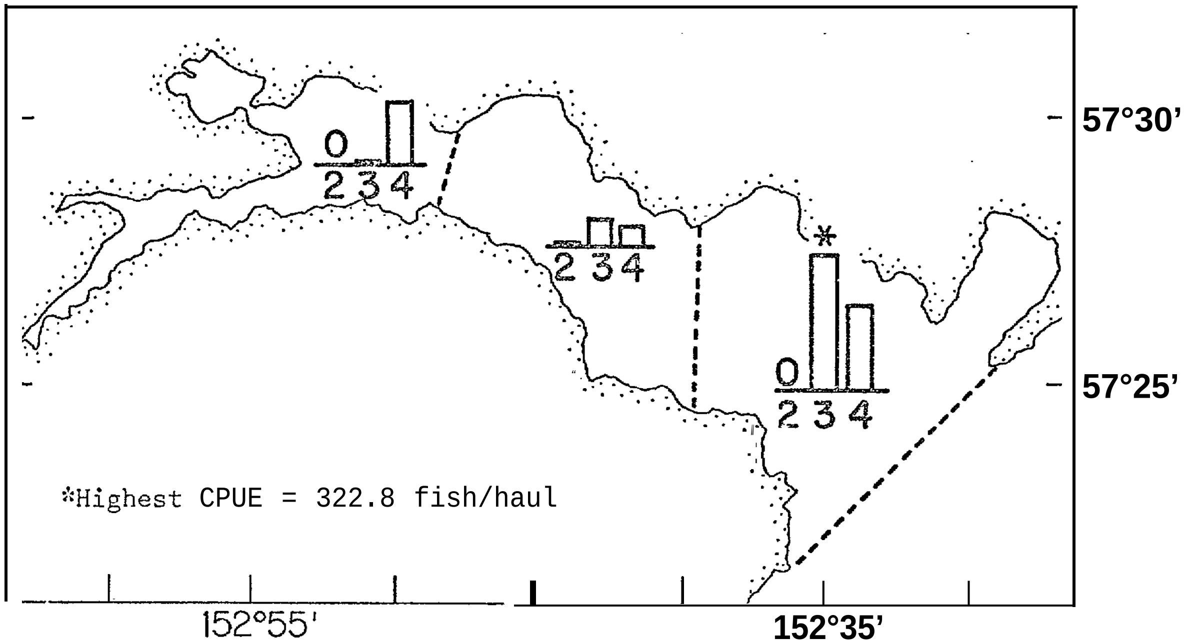


Fig. 6A & B. Townet CPUE of capelin in cruises 2-4 and in various regions of Ugak Bay (A, top) and Kaiugnak Eay (B, bottom). The cruise numbers are indicated below the bars. The diurnal catches in Alitak Bay were too small to warrant graphing.



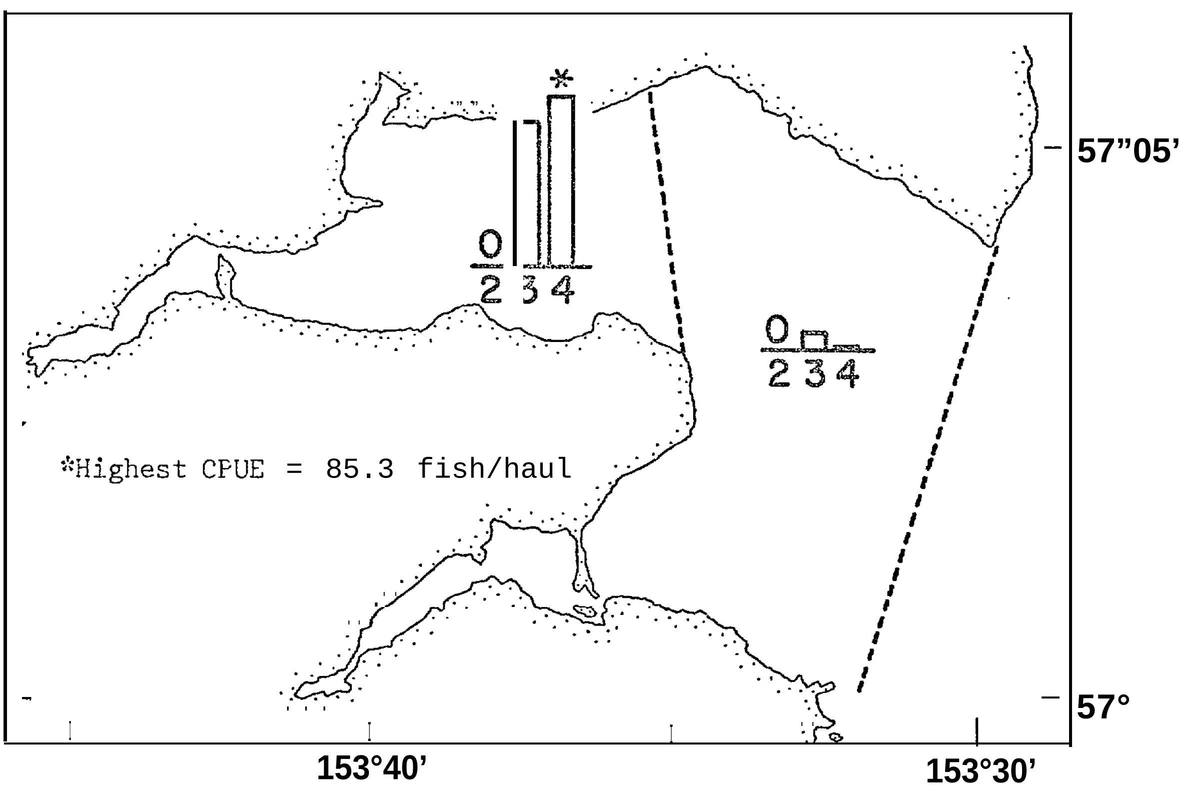


Fig. 7A E B. Townet CPUE of Pacific sandfish in cruises 2-4 and in various regions of Ugak Bay (A, top) and Kaiugnak Bay (B, bottom). The cruise numbers are indicated below the bars. The diurnal catches in Alitak Bay were too small to warrant graphing.

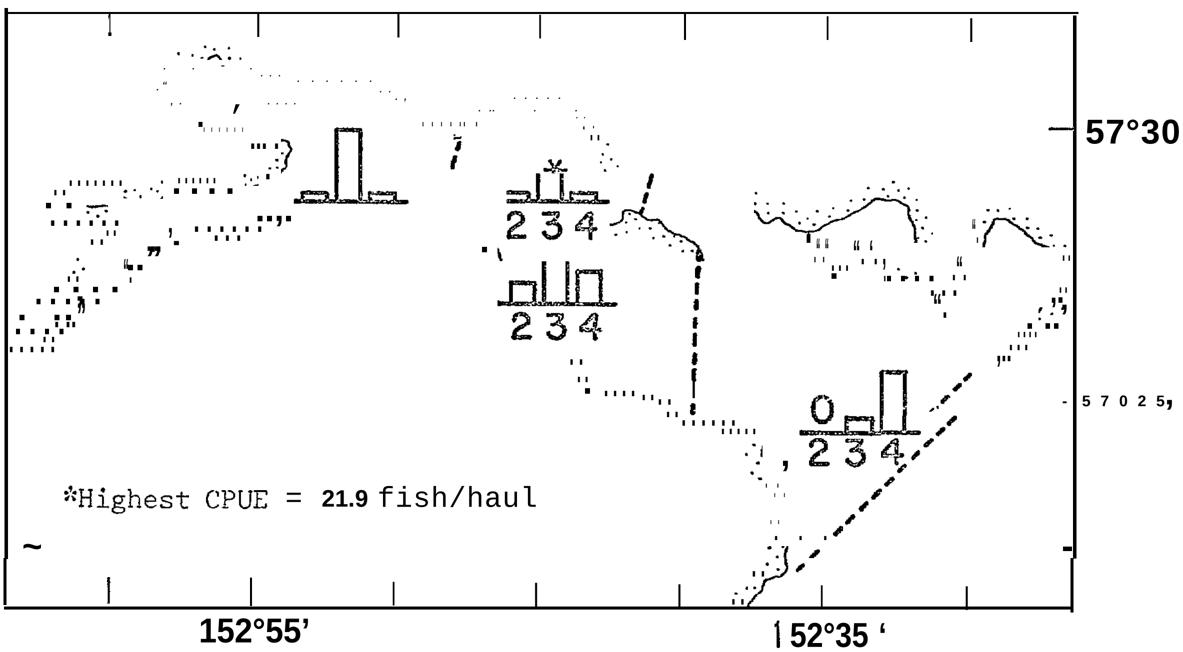


Fig. 8A. Townet CPUE of age 0 pink salmon in cruises 2-4 and in various regions of Ugak Bay. The cruise numbers are indicated below the bars. Catches in Kaiugnak Bay were too small to warrant graphing.

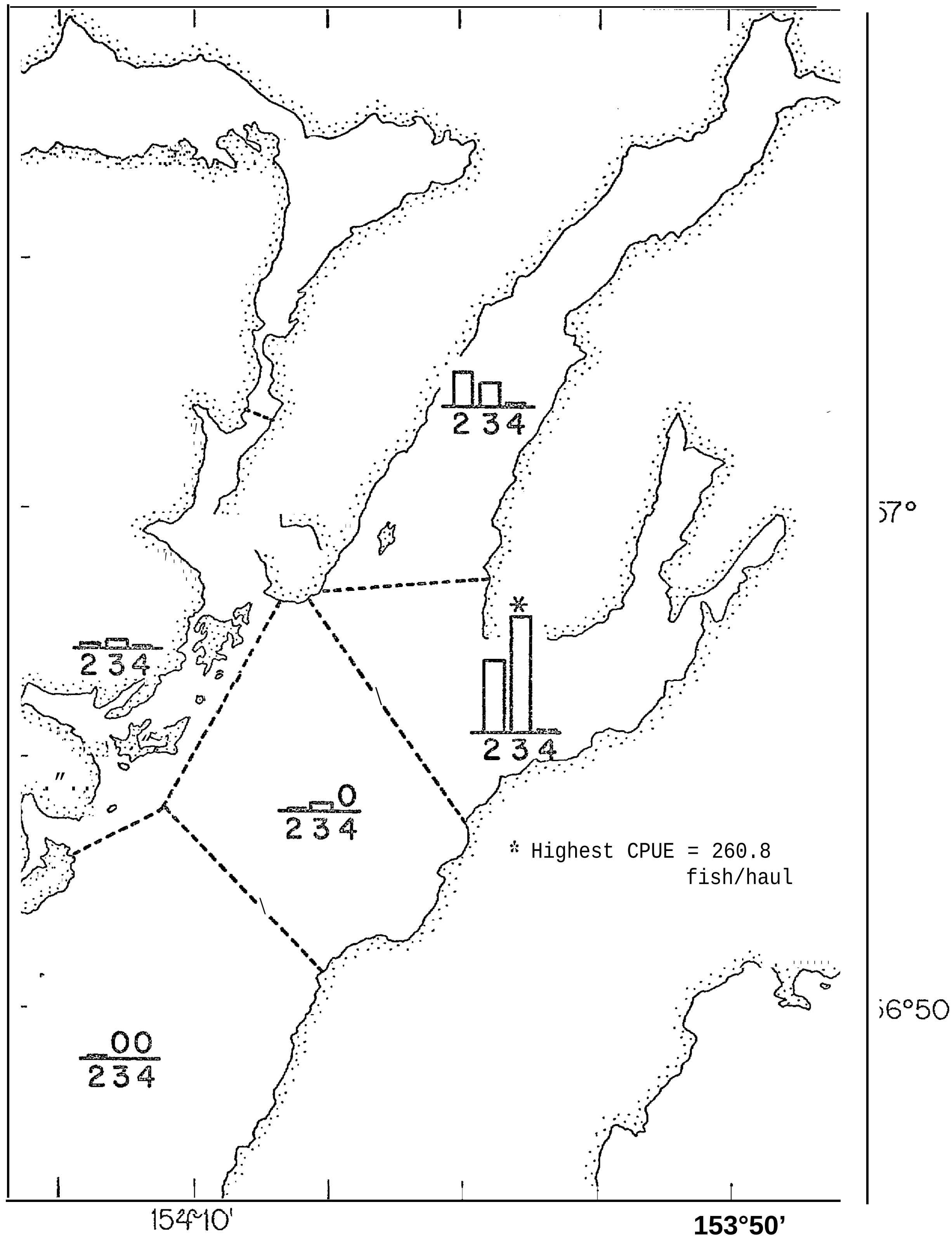


Fig. 8B. Townet CPUE of age 0 pink salmon in cruises 2-4 and in various regions of Alitak Bay. The cruise numbers are indicated below the bars.

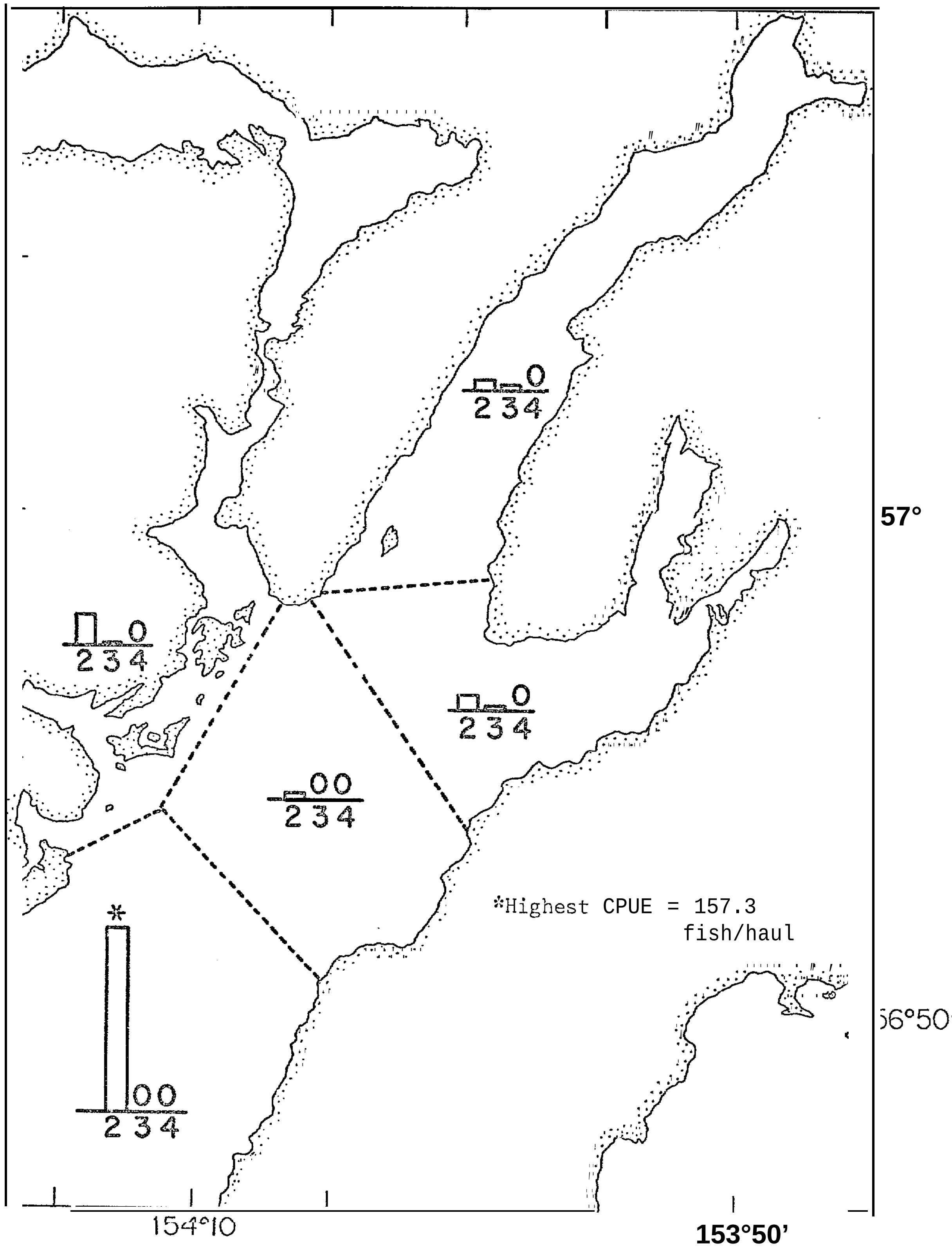


Fig. 9. Townet CPUE of age 1 greenings (*Hexagrammos* spp.) in cruises 2-4 and in various regions of Alitak Bay. The cruise numbers are indicated below the bars, Catches in Ugak and Kaiugnak Bays were too small to warrant graphing.

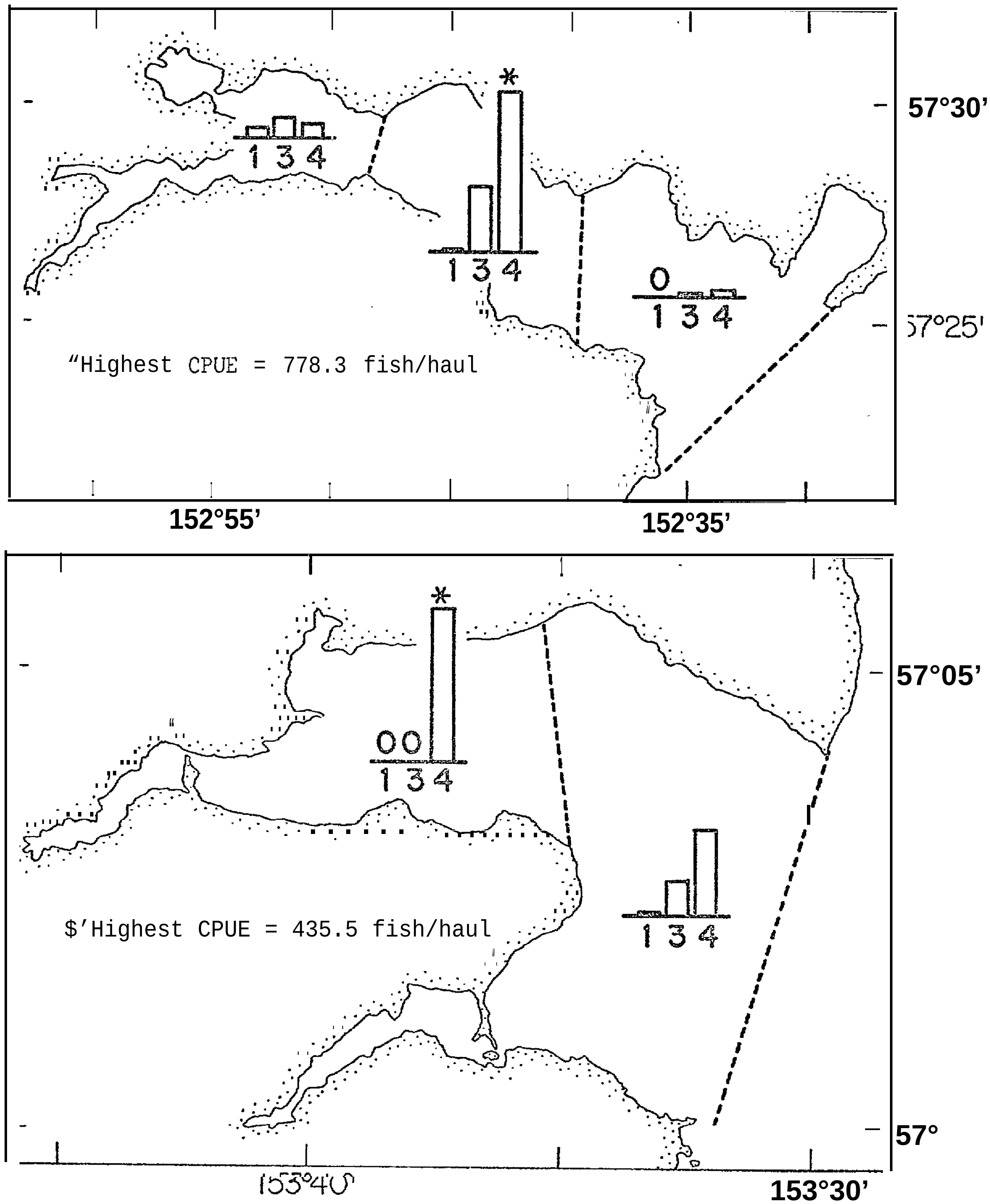


Fig. 10A & B. Midwater trawl CPUE of capelin in cruises 1, 3, and 4 and in various regions of Ugak Bay (A, top) and Kaiugnak Bay (B, bottom). The cruise numbers are indicated below the bars.

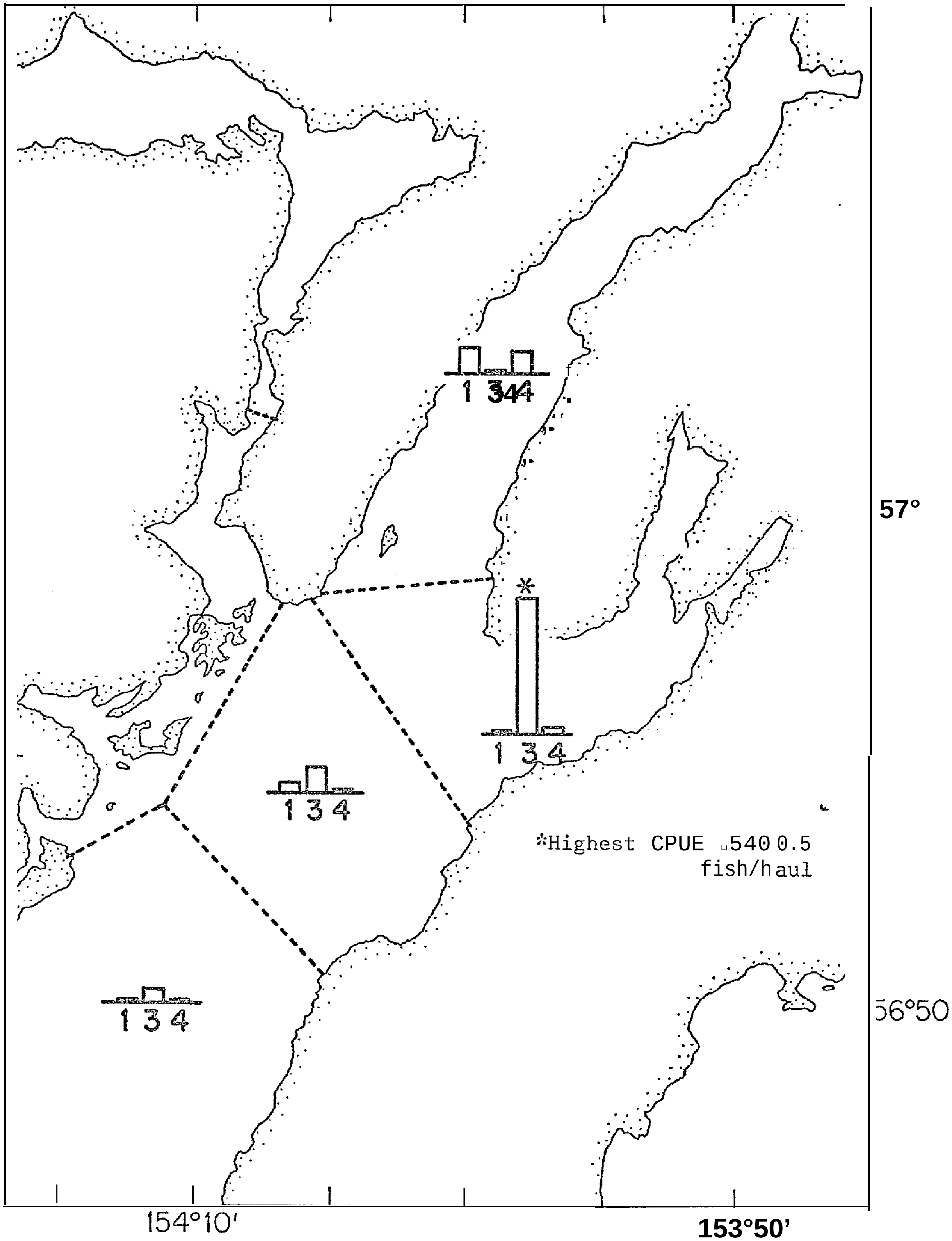


Fig. 10C. Midwater trawl CPUE of capelin in cruises 1, 3, and 4 and in various regions of Alitak Bay. The cruise numbers are indicated below the bars.

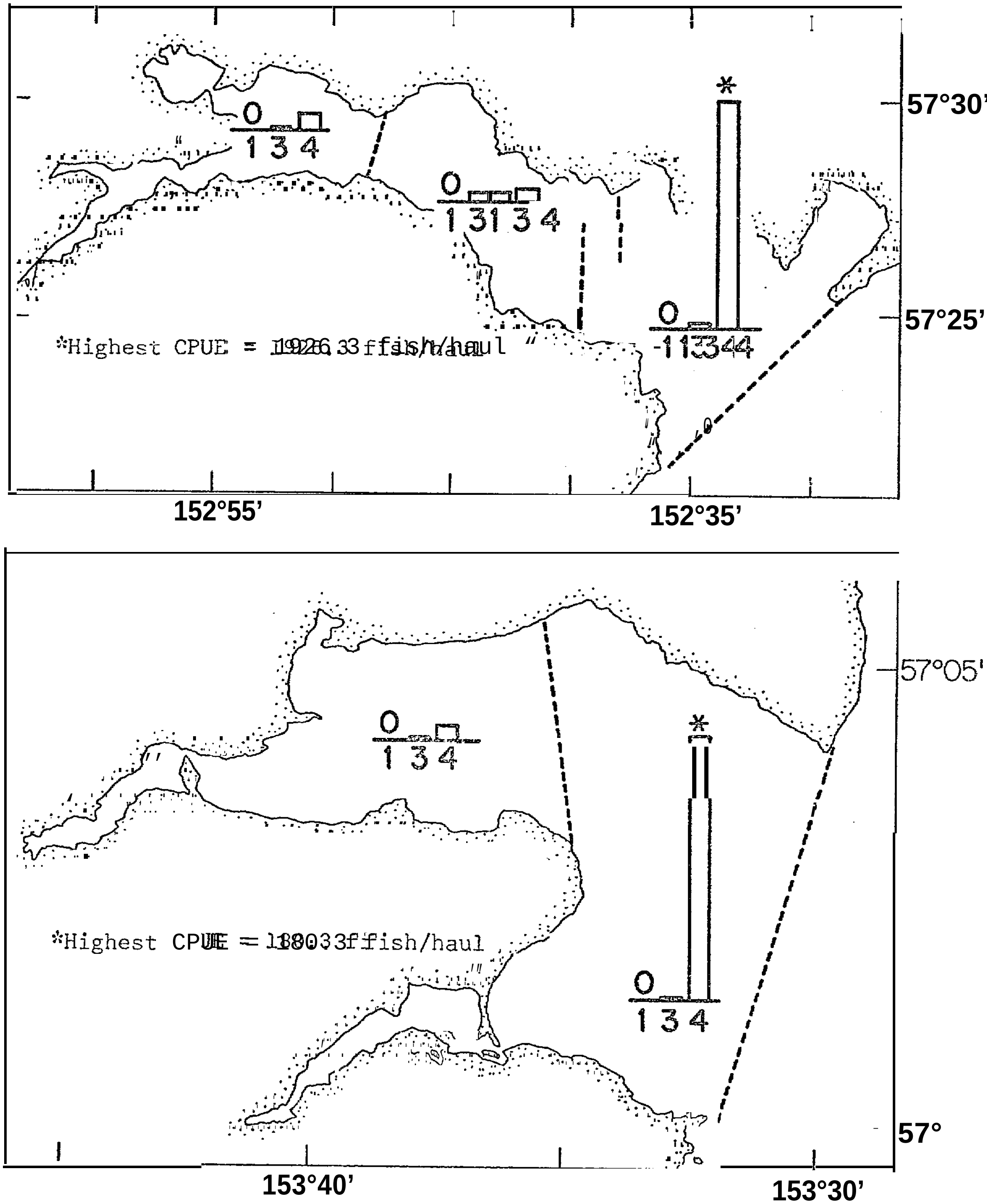


Fig. 11A & B. Midwater trawl CPUE of Pacific sandfish in cruises 1, 3, and 4 and in various regions of Ugak Bay (A, top) and Kaiugnak Bay (B, bottom). The cruise numbers are indicated below the bars.

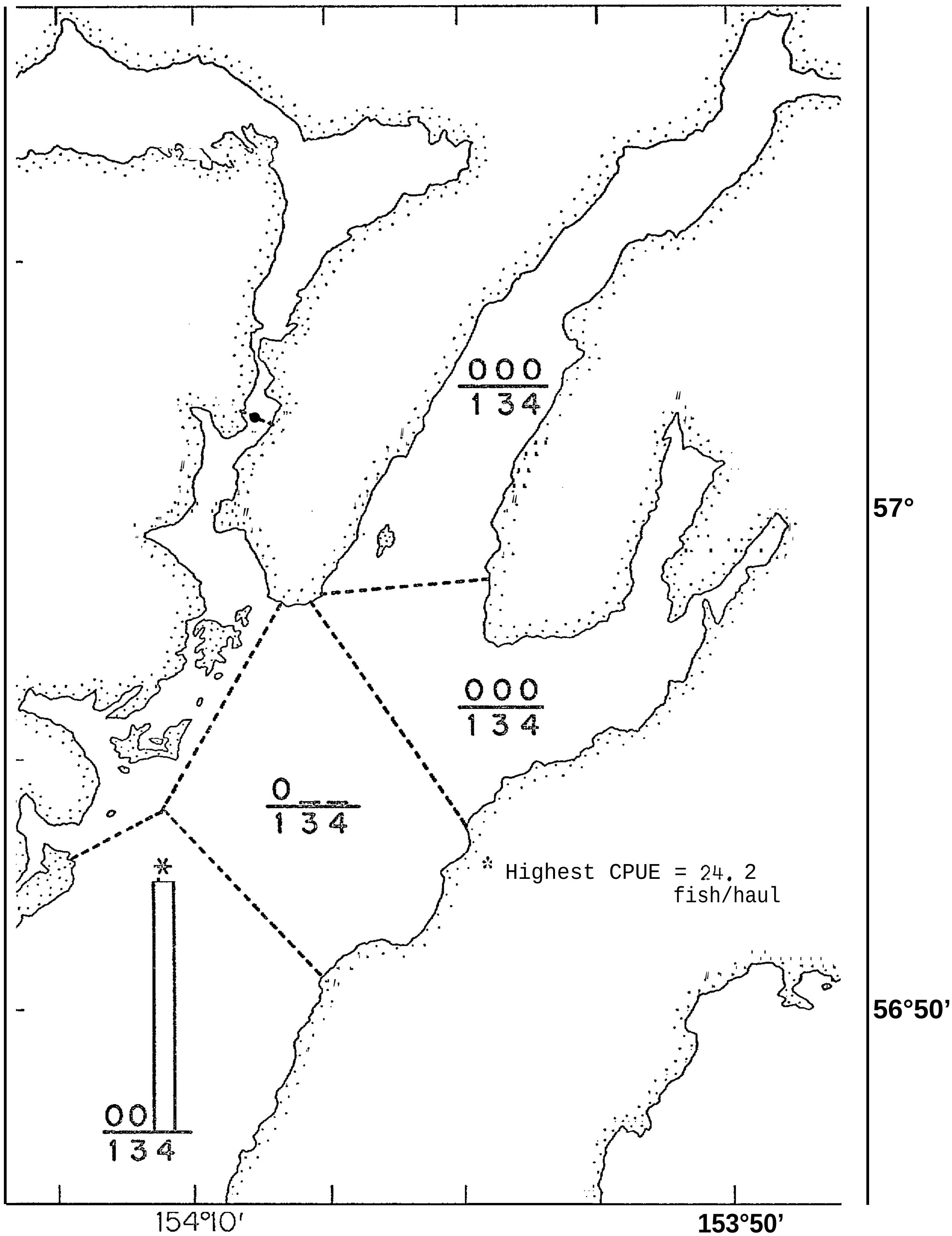
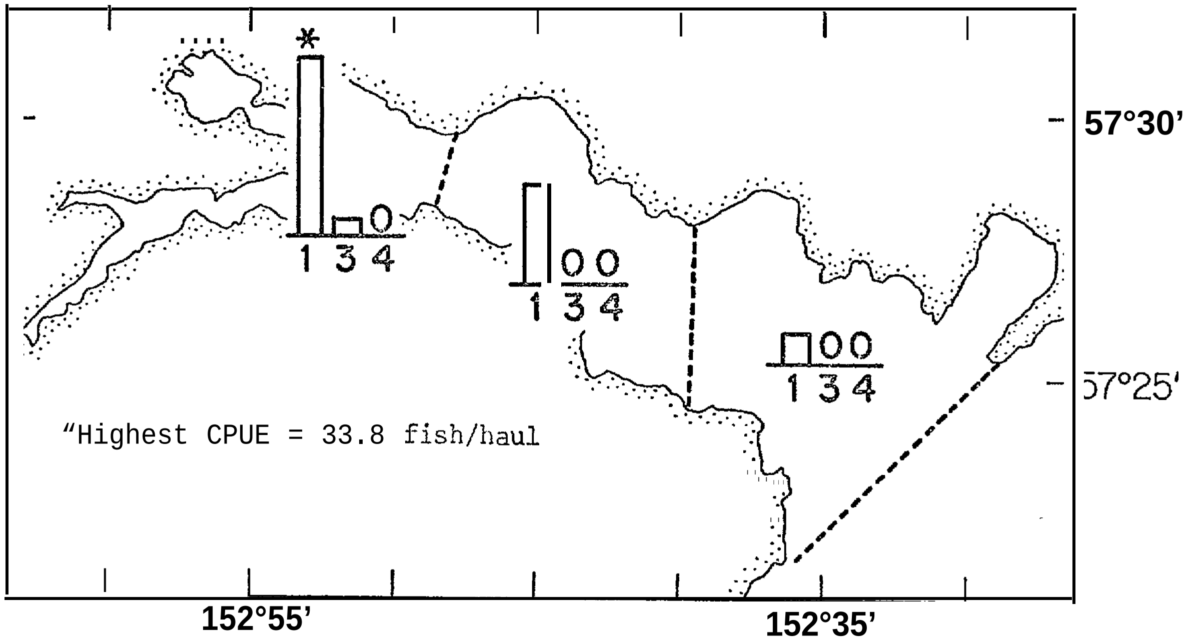


Fig. 11C. Midwater trawl CPUE of Pacific sandfish in cruises 1, 3 and 4 and in various regions of Alitak Bay. The cruise numbers are indicated below the bars.



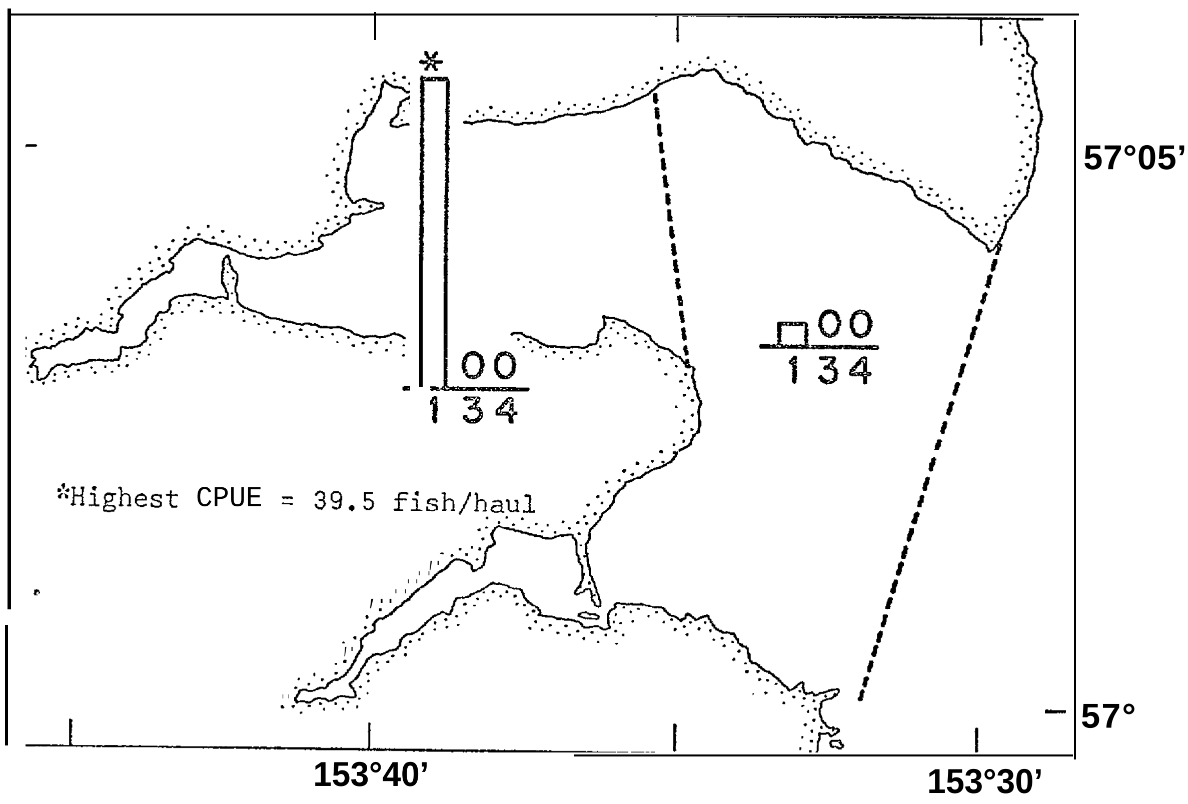
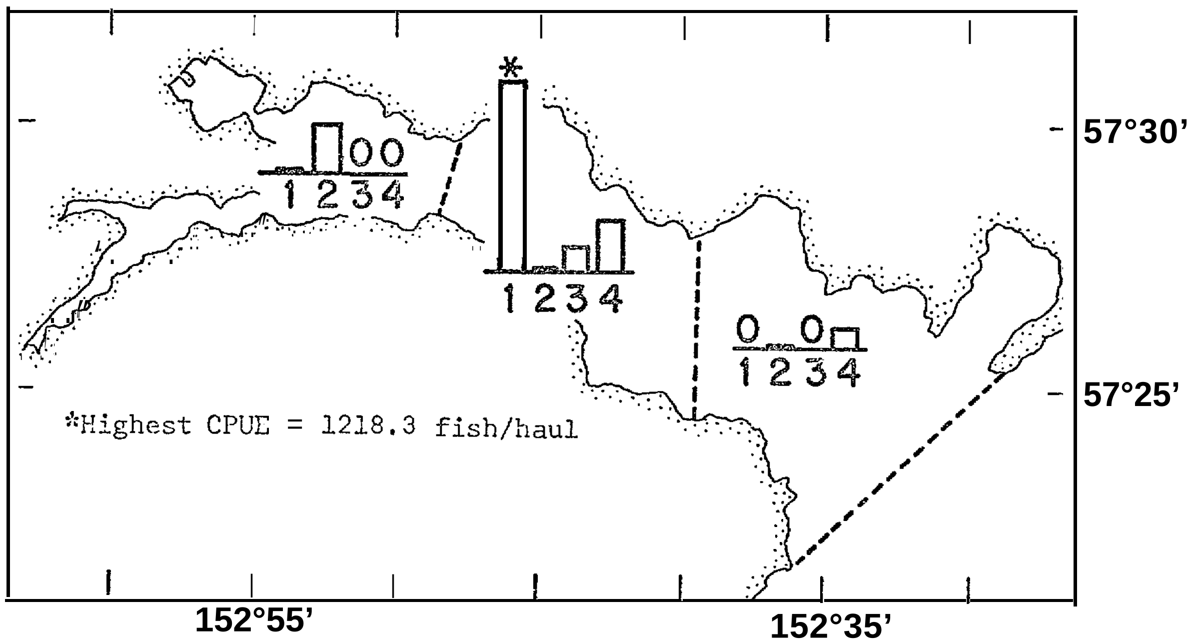


Fig. 12A & B. Midwater trawl CPUE of sand lance in cruises 1, 3, and 4 and in various regions of Ugak Bay (A, top) and Kaiugnak Bay (B, bottom). The cruise numbers are indicated below the bars. Catches in Alitak Bay were too small to warrant graphing.



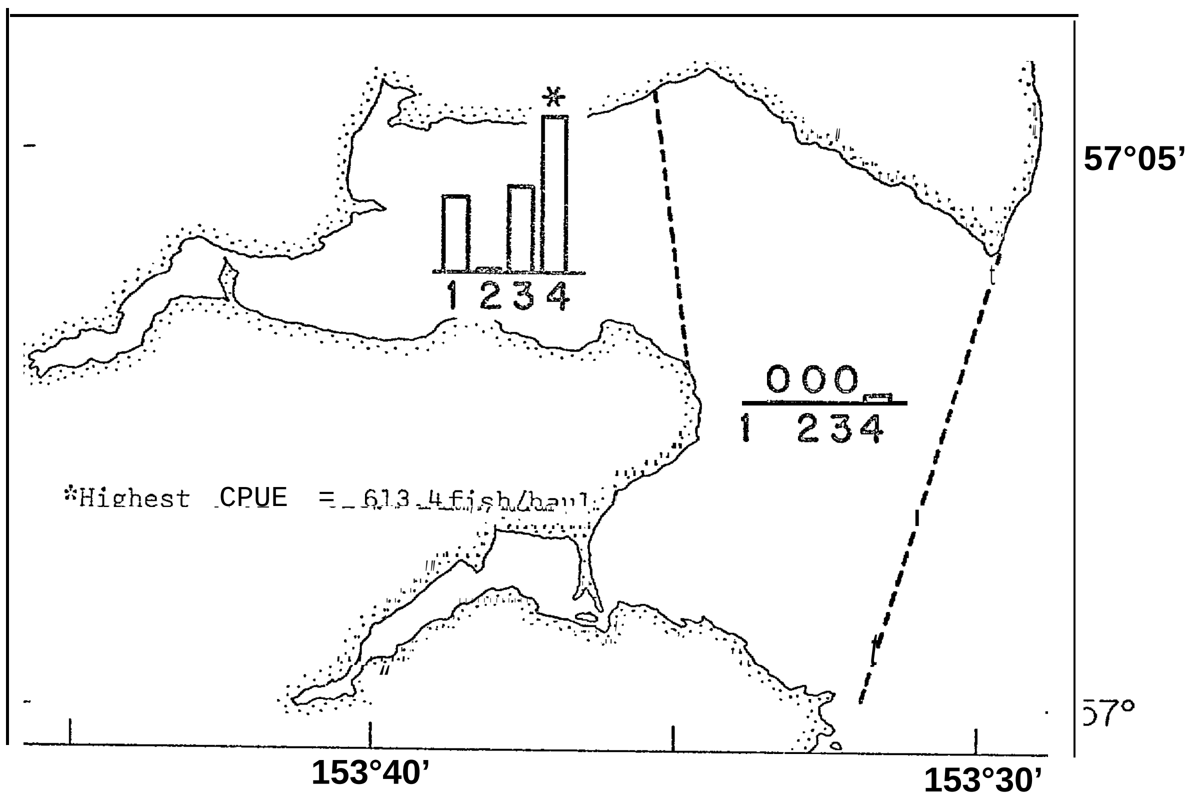


Fig. 13A & B. Beach seine CPUE of sand lance in cruises 1-4 and in various regions of Ugak Bay (A, top) and Kaiugnak Bay (B, bottom). The cruise numbers are indicated below the bars.

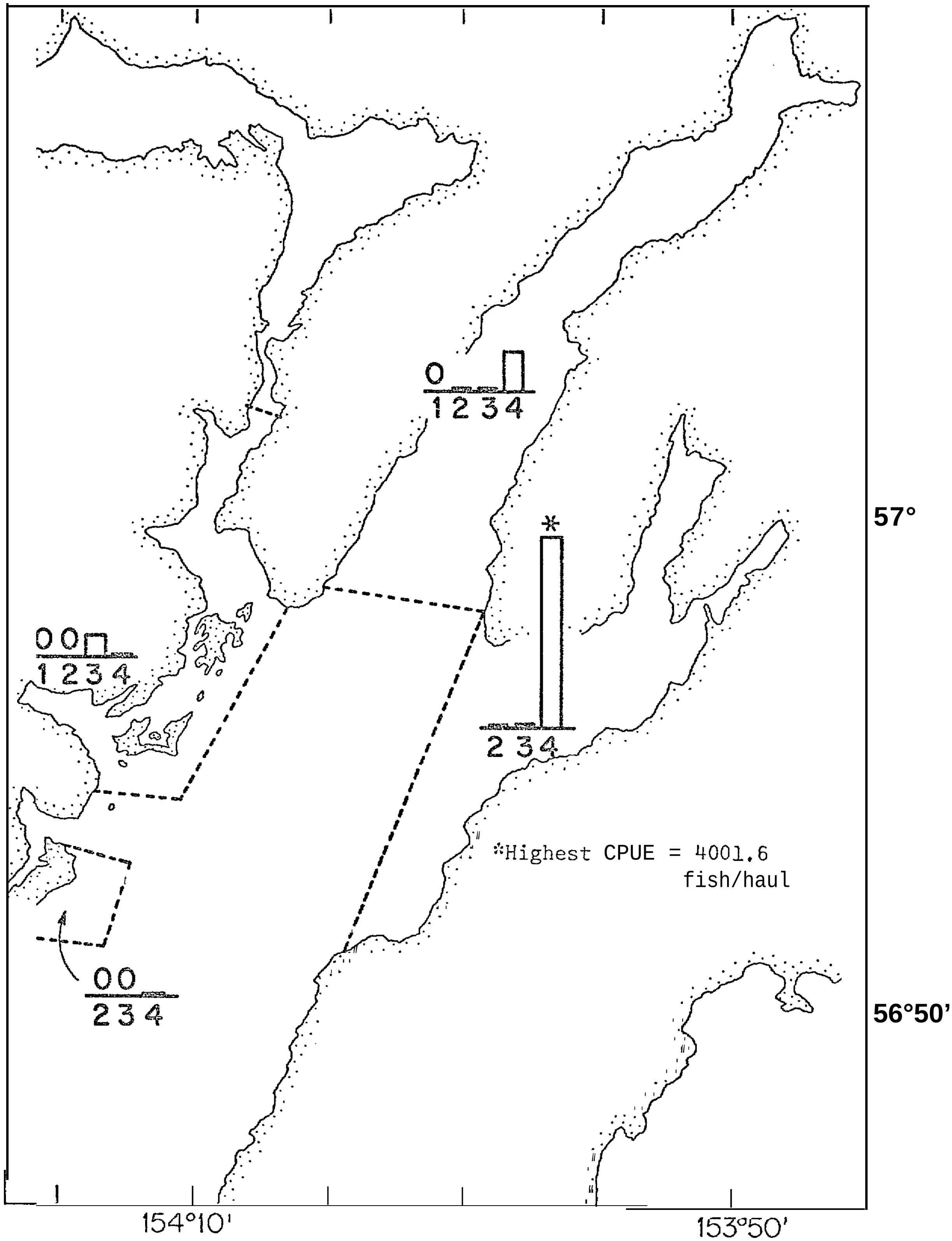
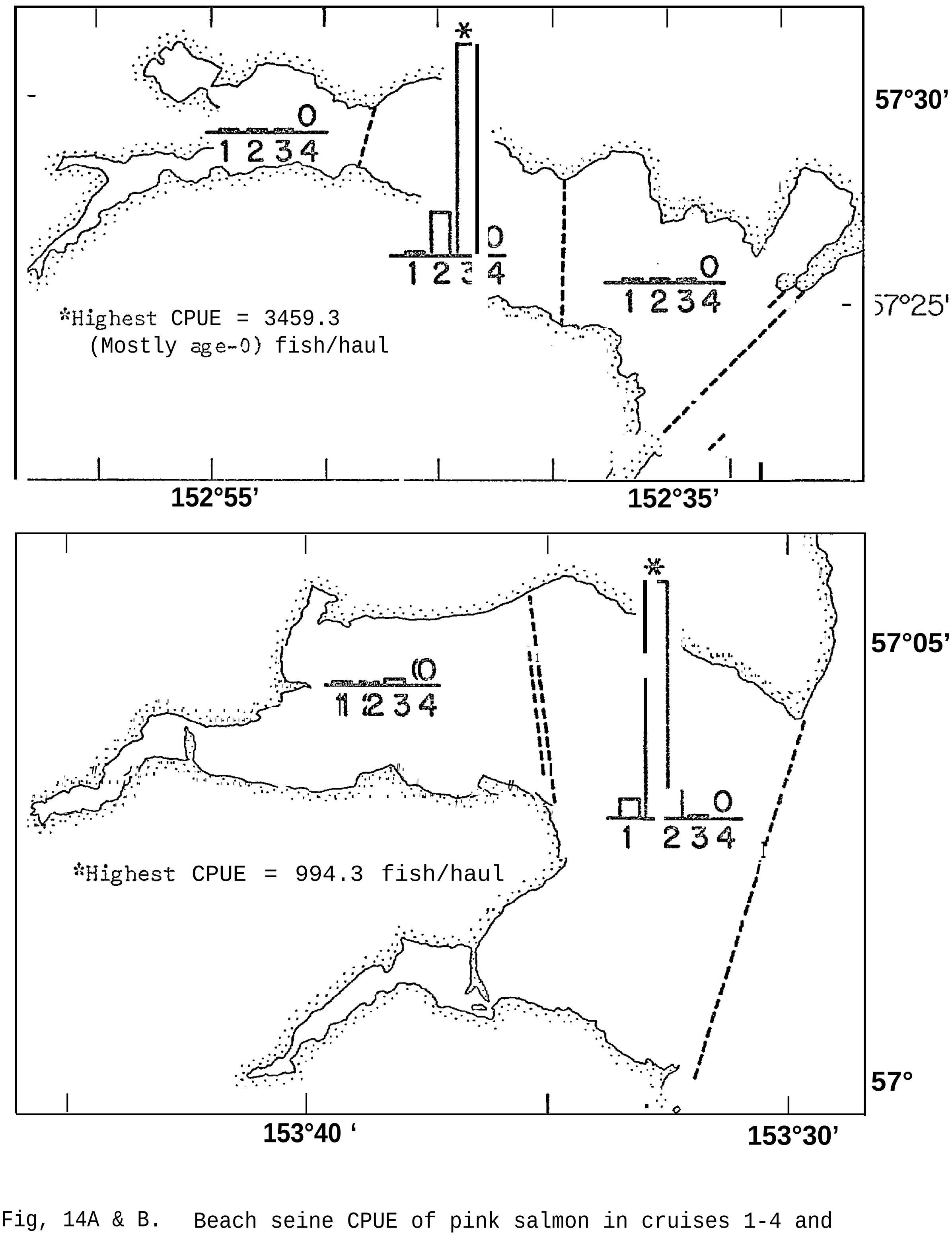


Fig. 13C. Beach seine CPUE of sand lance in cruises 1-4 and in various regions of Alitak Bay. The cruise numbers are indicated below the bars.



Fig, 14A & B. Beach seine CPUE of pink salmon in cruises 1-4 and in various regions of Ugak Bay (A, top) and Kaiugnak Bay (B, bottom). The cruise numbers are indicated below the bars.

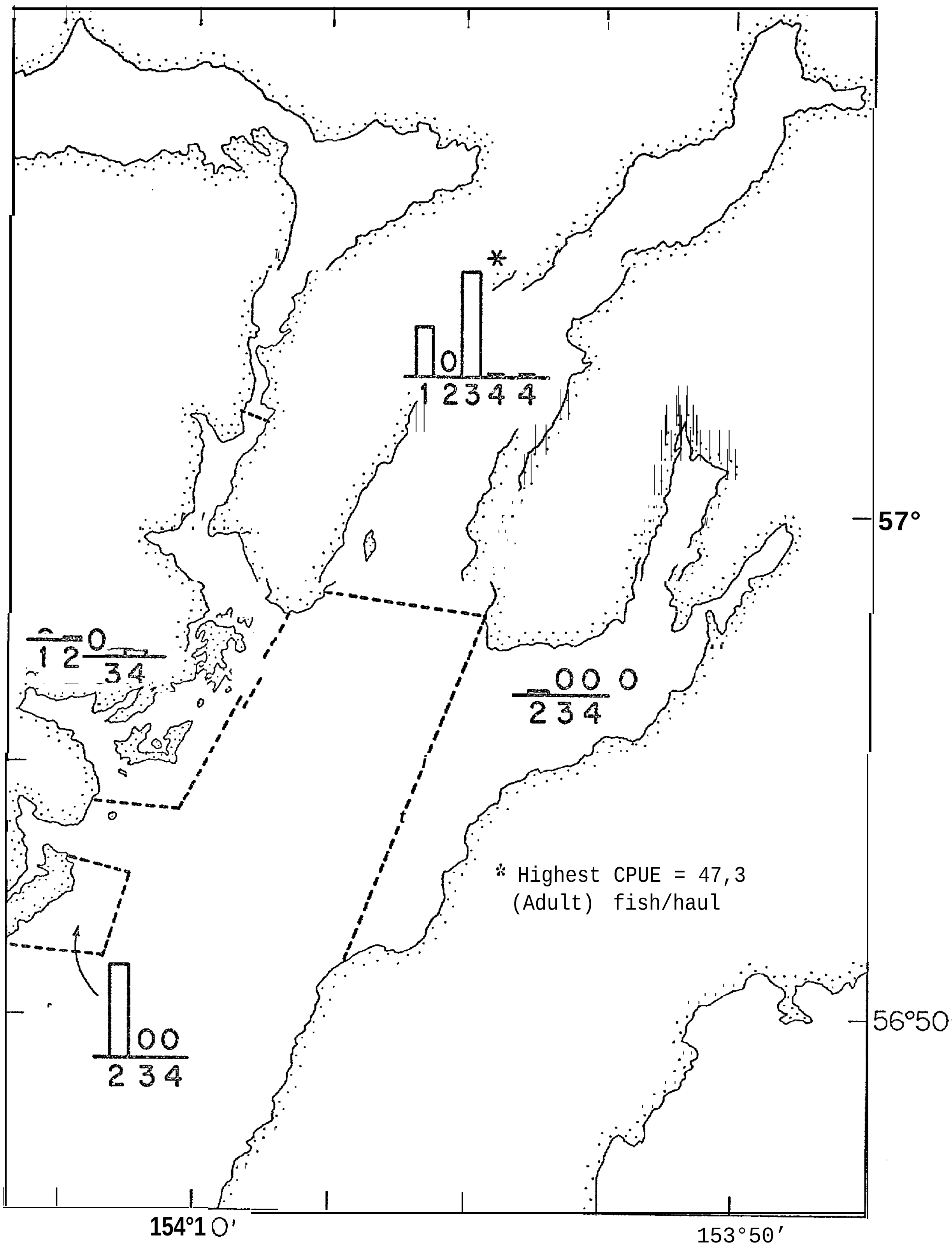
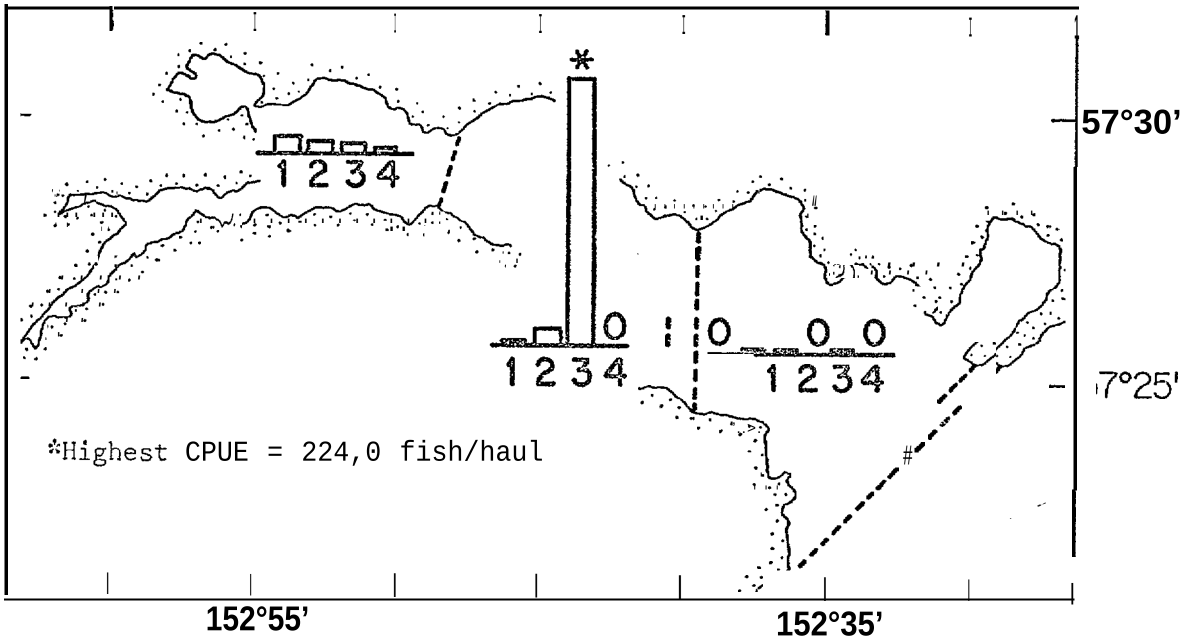


Fig. 14C. Beach seine CPUE of pink salmon in cruises 1-4 and in various regions of Alitak Bay. The cruise numbers are indicated below the bars.



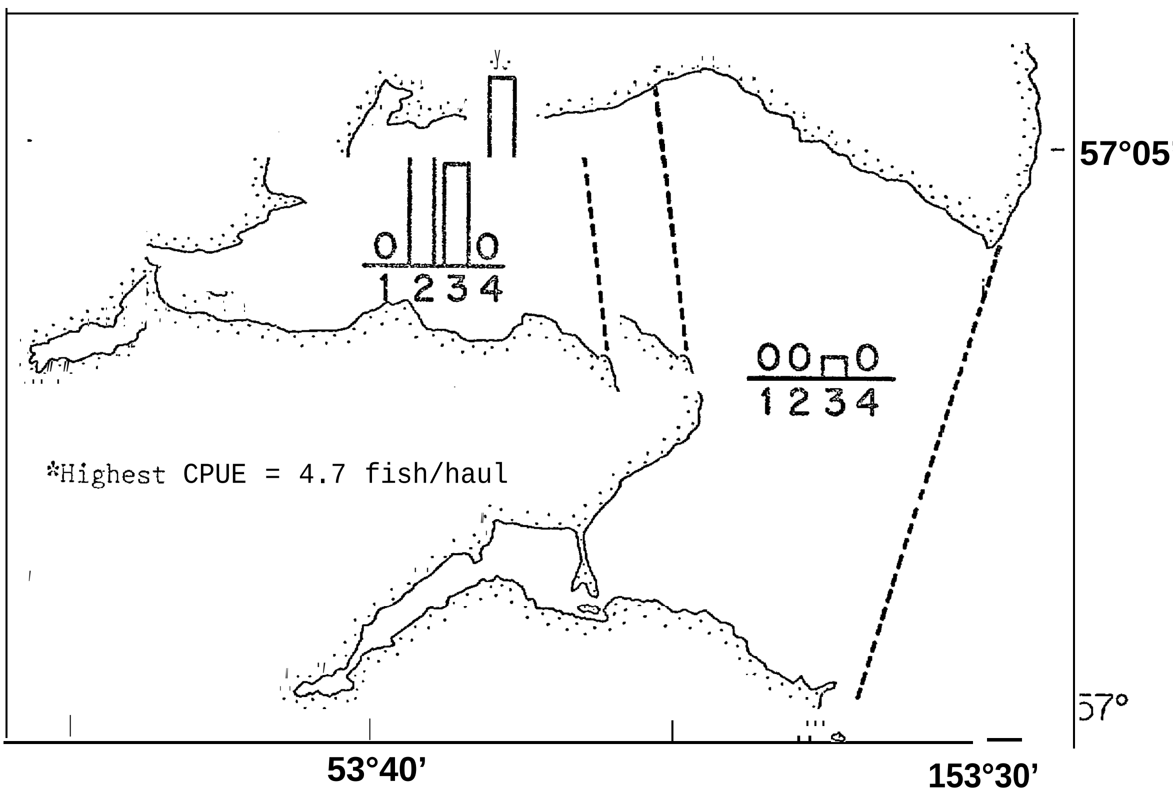


Fig. 15A & B. Beach seine CPUE of chum salmon in cruises 1-4 and in various regions of Ugak Bay (A, top) and Kaiugnak Bay (B, bottom). The cruise numbers are indicated below the bars. Catches in Alitak Bay were entirely from one cruise and region, and do not warrant graphing.

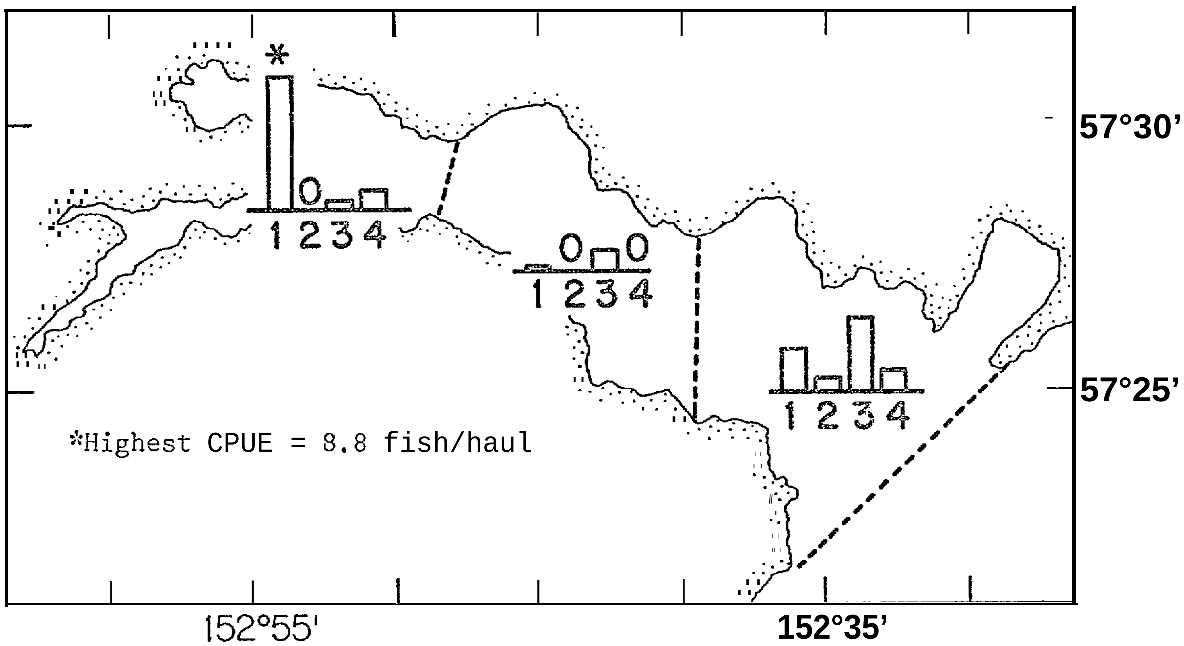


Fig. 16A. Beach seine CPUE of Dolly Varden in cruises 1-4 and in various regions of Ugak Bay. Catches in Kaiugnak Bay were too small to warrant graphing. The cruise numbers are indicated below the bars.

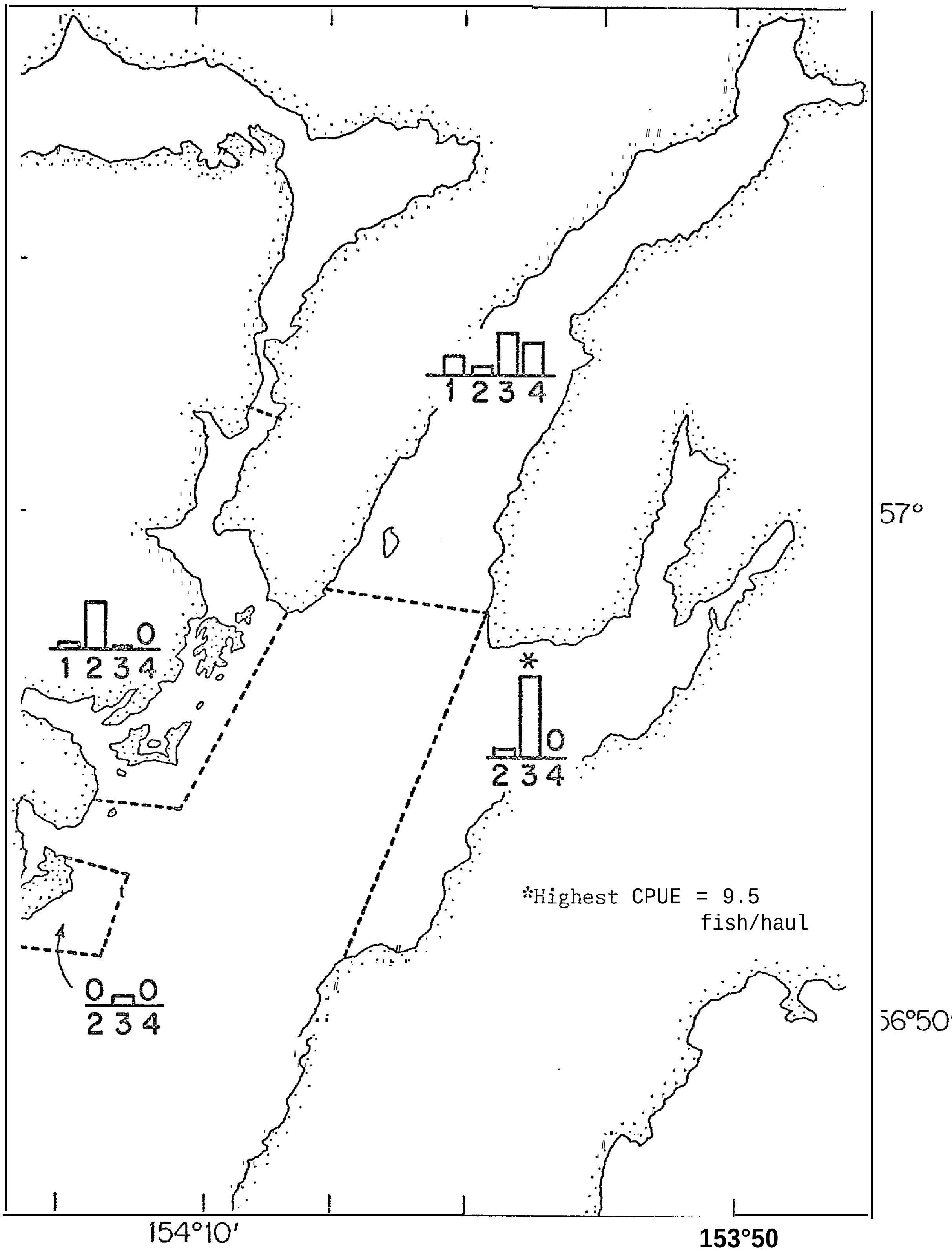


Fig. 16B. Beach seine CPUE of Dolly Varden in cruises 1-4 and in various regions of Alitak Bay. The cruise numbers are indicated below the bars.

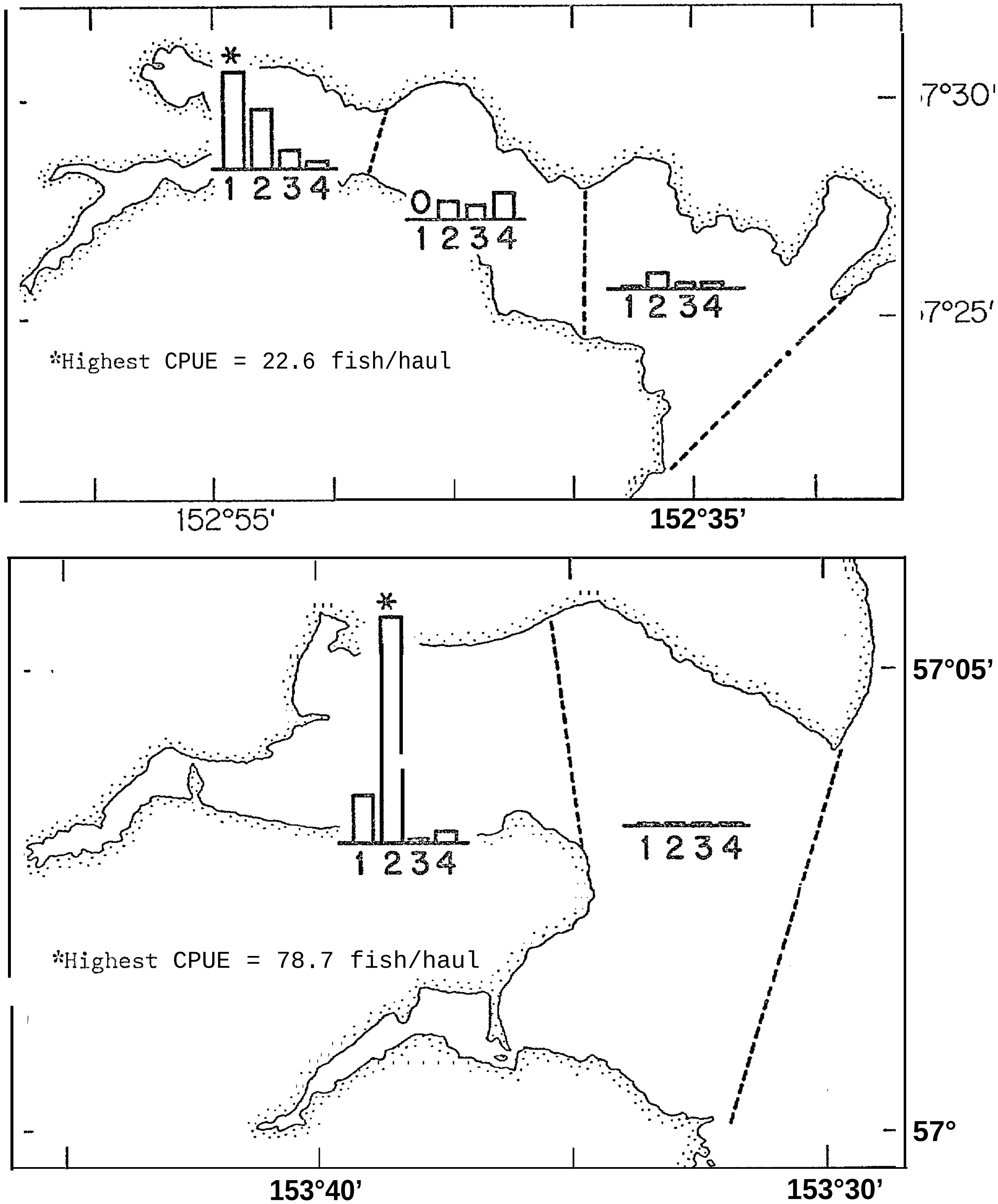


Fig. 17A & B. Beach seine CPUE of great sculpin in cruises 1-4 and in various regions of Ugak Bay (A, top) and Kaiugnak Bay (B, bottom). The cruise numbers are indicated below the bars.

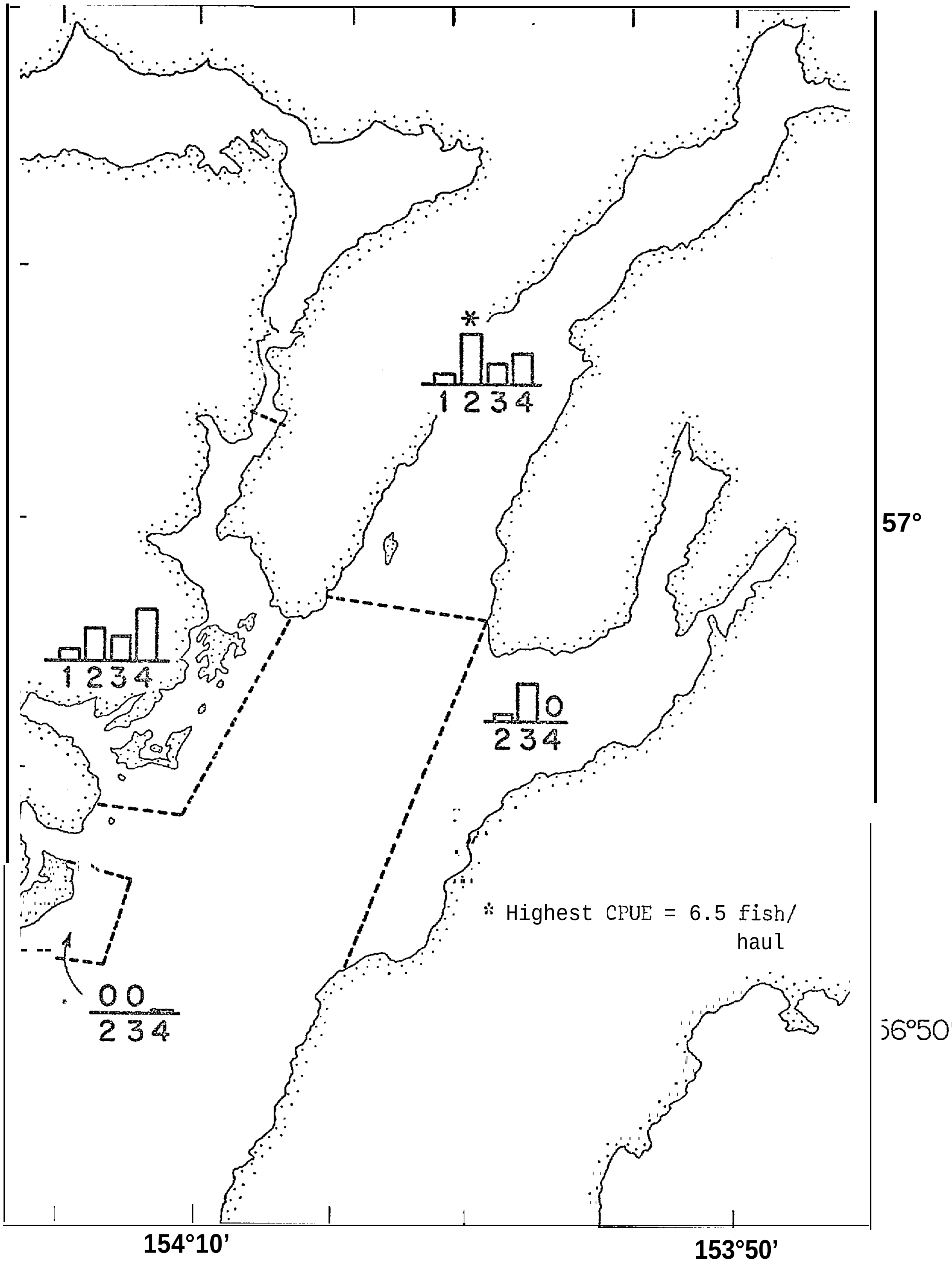
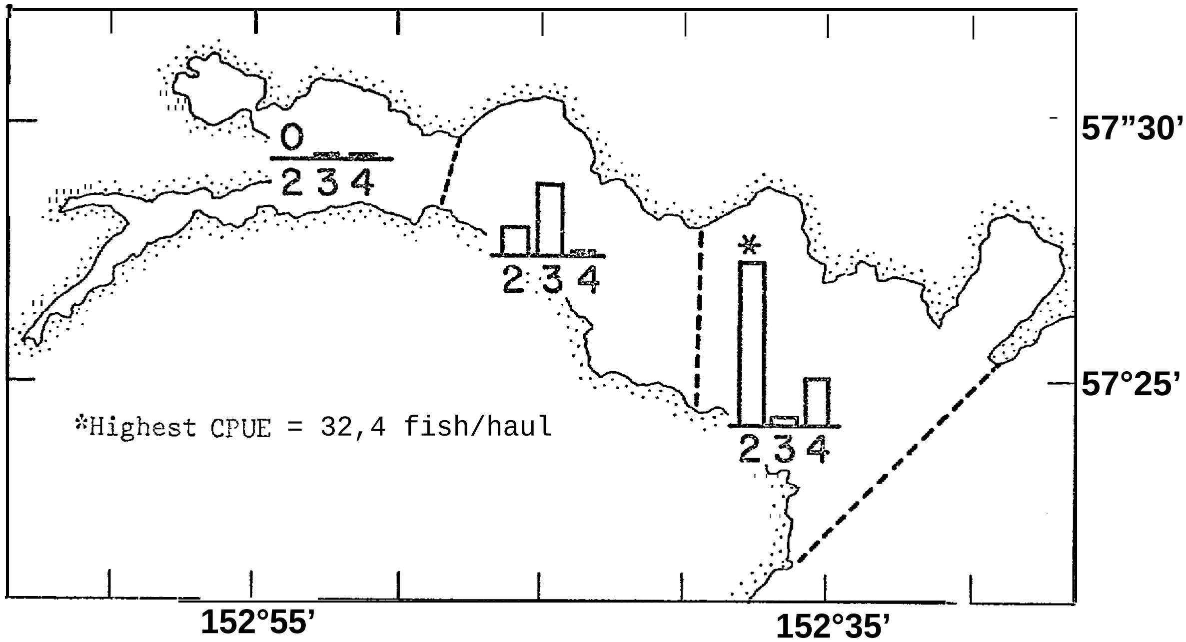


Fig. 17C. Beach seine CPUE of great sculpin in cruises 1-4 and in various regions of Alitak Bay. The cruise numbers are indicated below the bars.



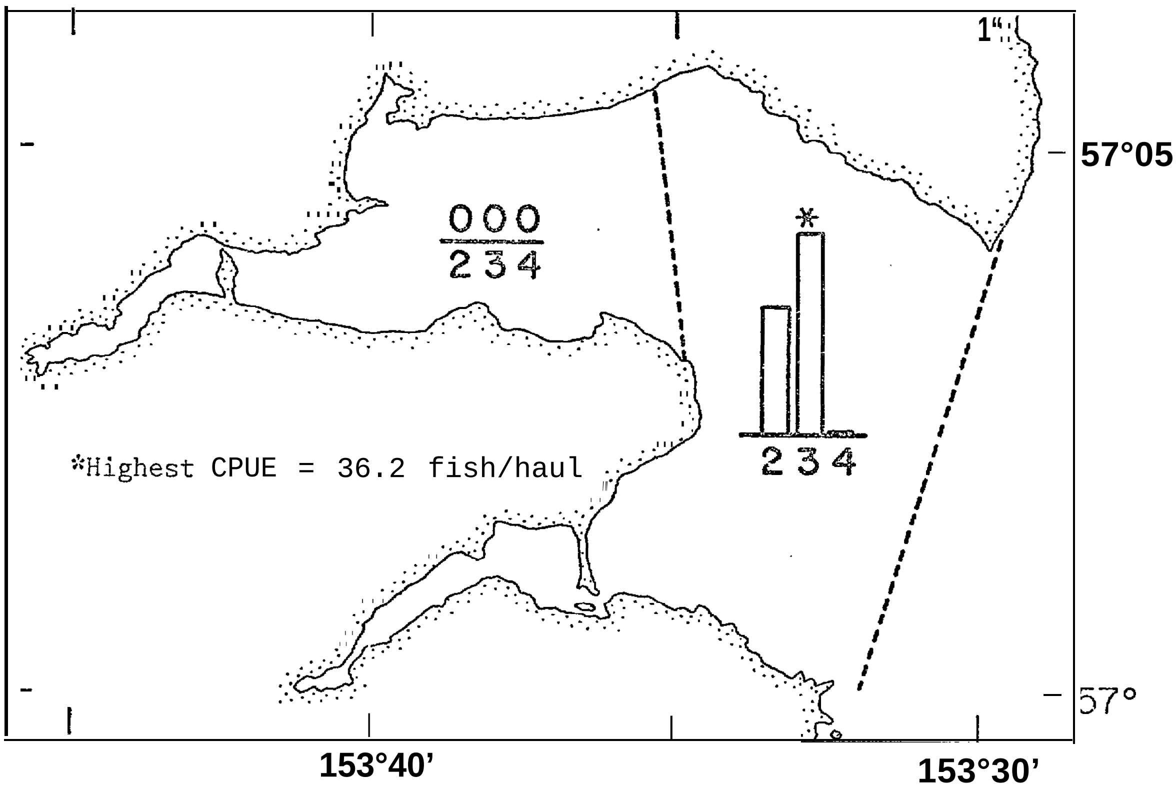
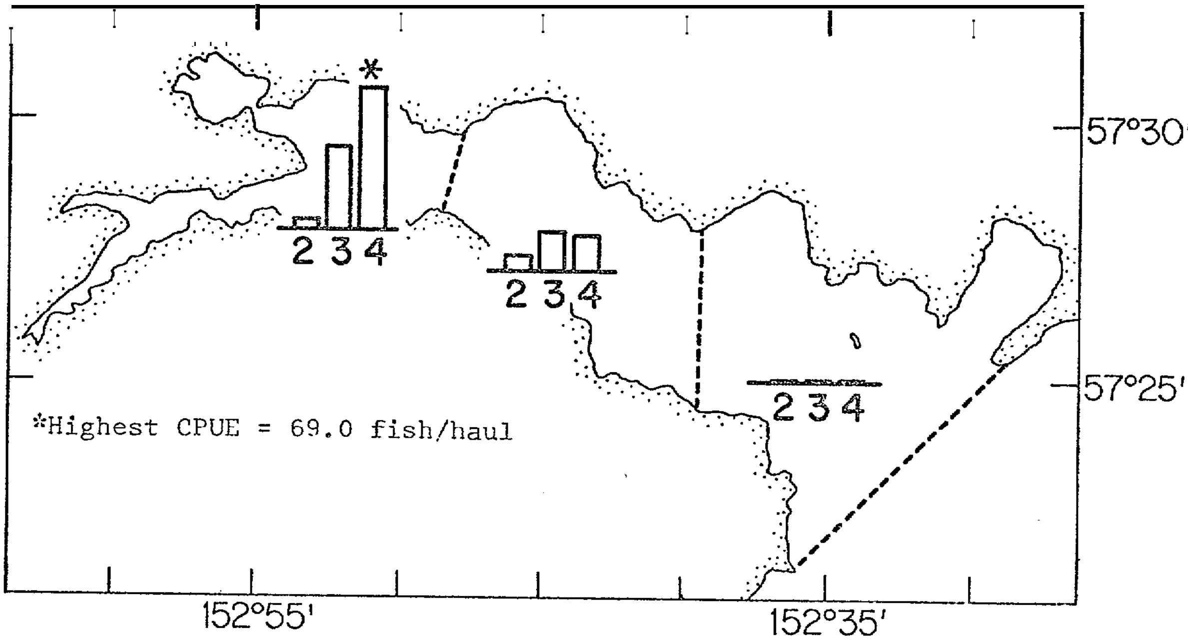


Fig. 18A & B. Try net CPUE of snake prickleback in cruises 2-4 and in various regions of Ugak Bay (A, top) and Kaiugnak Bay (B, bottom). The cruise numbers are indicated below the bars. Catches in Alitak Bay were too small to warrant graphing.



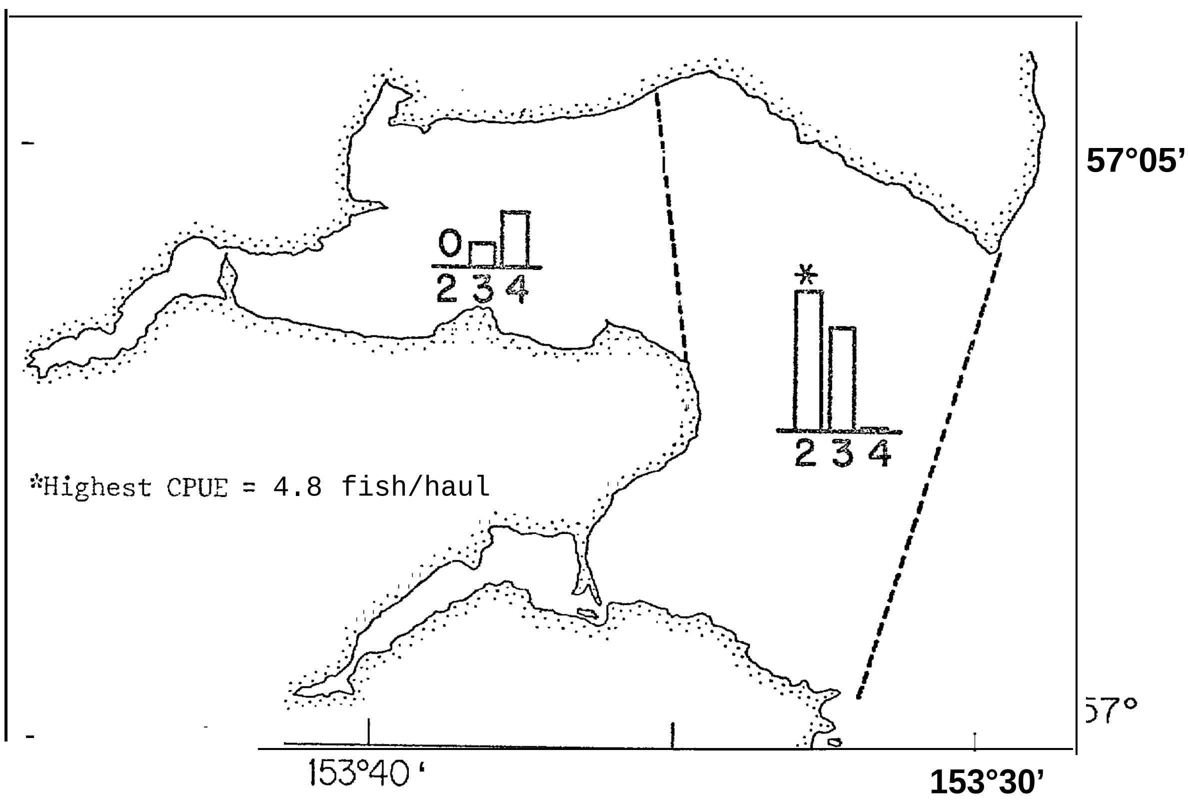


Fig. 19A & B. Try net CPUE of yellowfin sole in cruises 2-4 and in various regions of Ugak Bay (A, top) and Kaiugnak Bay (B, bottom). The cruise numbers indicated below the bars.

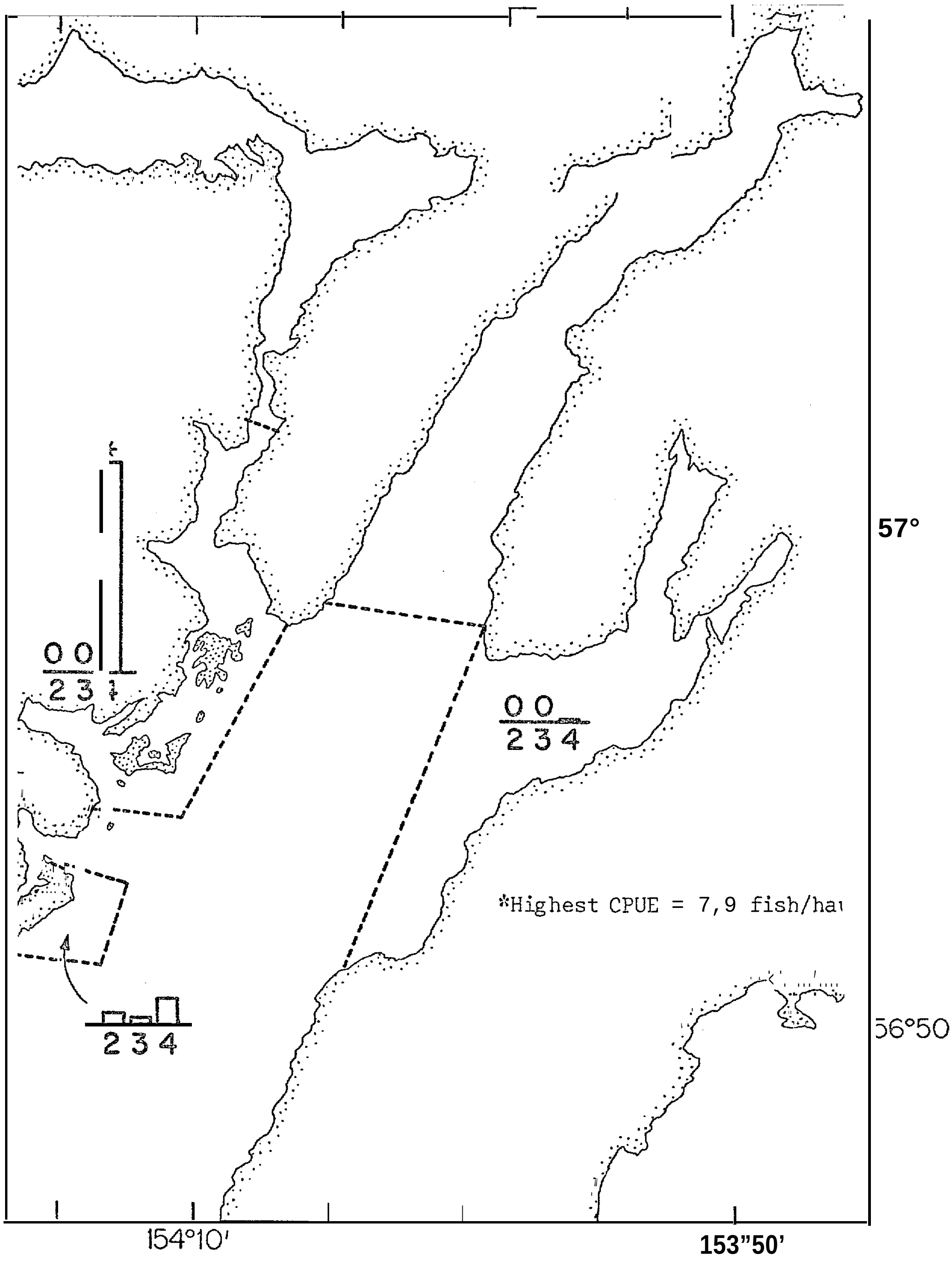


Fig. 19C. Try net CPUE of yellow fin sole in cruises 2-4 and in various regions of Alitak Bay. The cruise numbers are indicated below the bars.

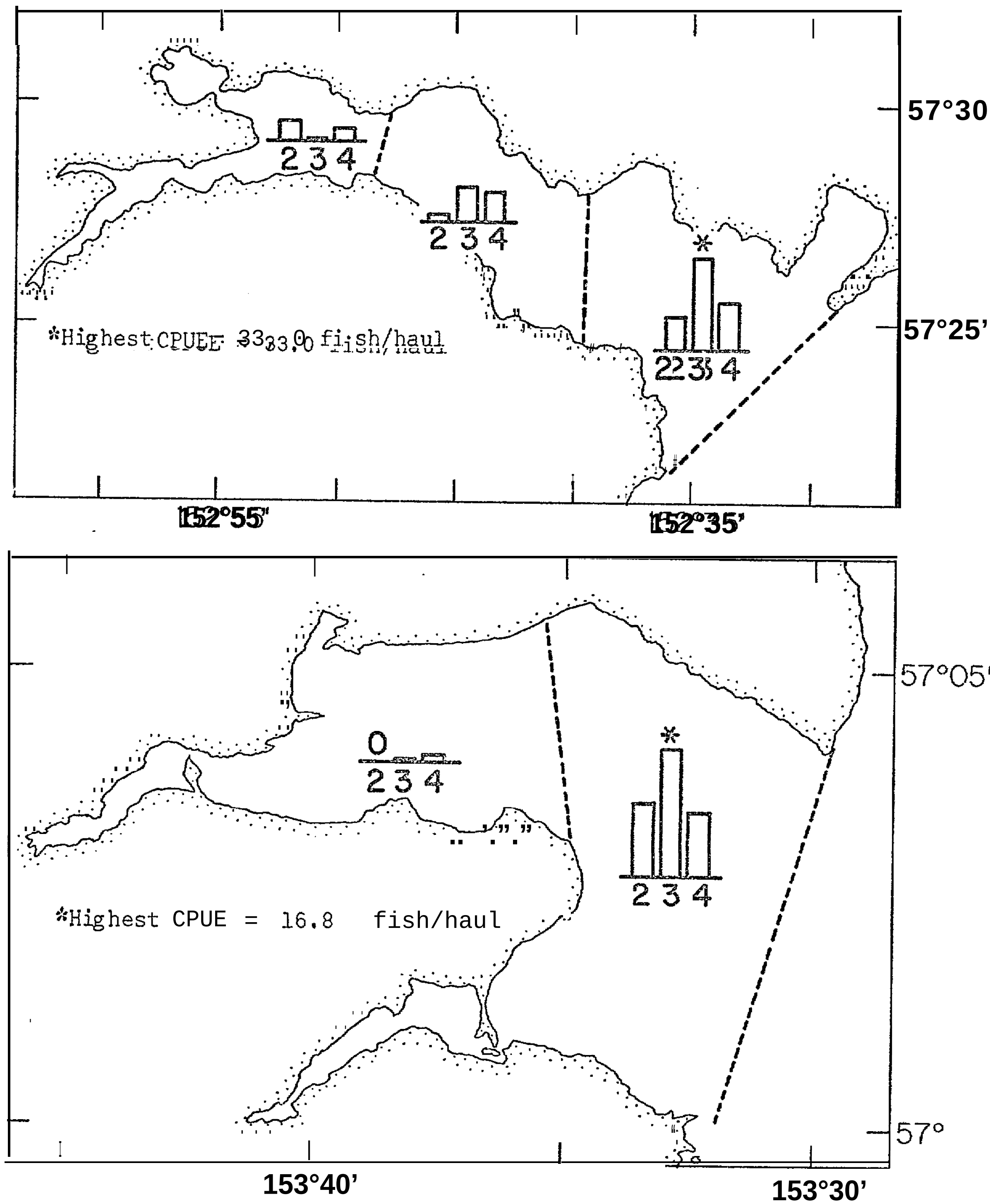


Fig. 20A & B. Try net CPUE of rock sole in cruises 2-4 and in various regions of Ugak Bay (A, top) and Kaiugnak Bay (B, bottom). The cruise numbers are indicated below the bars.

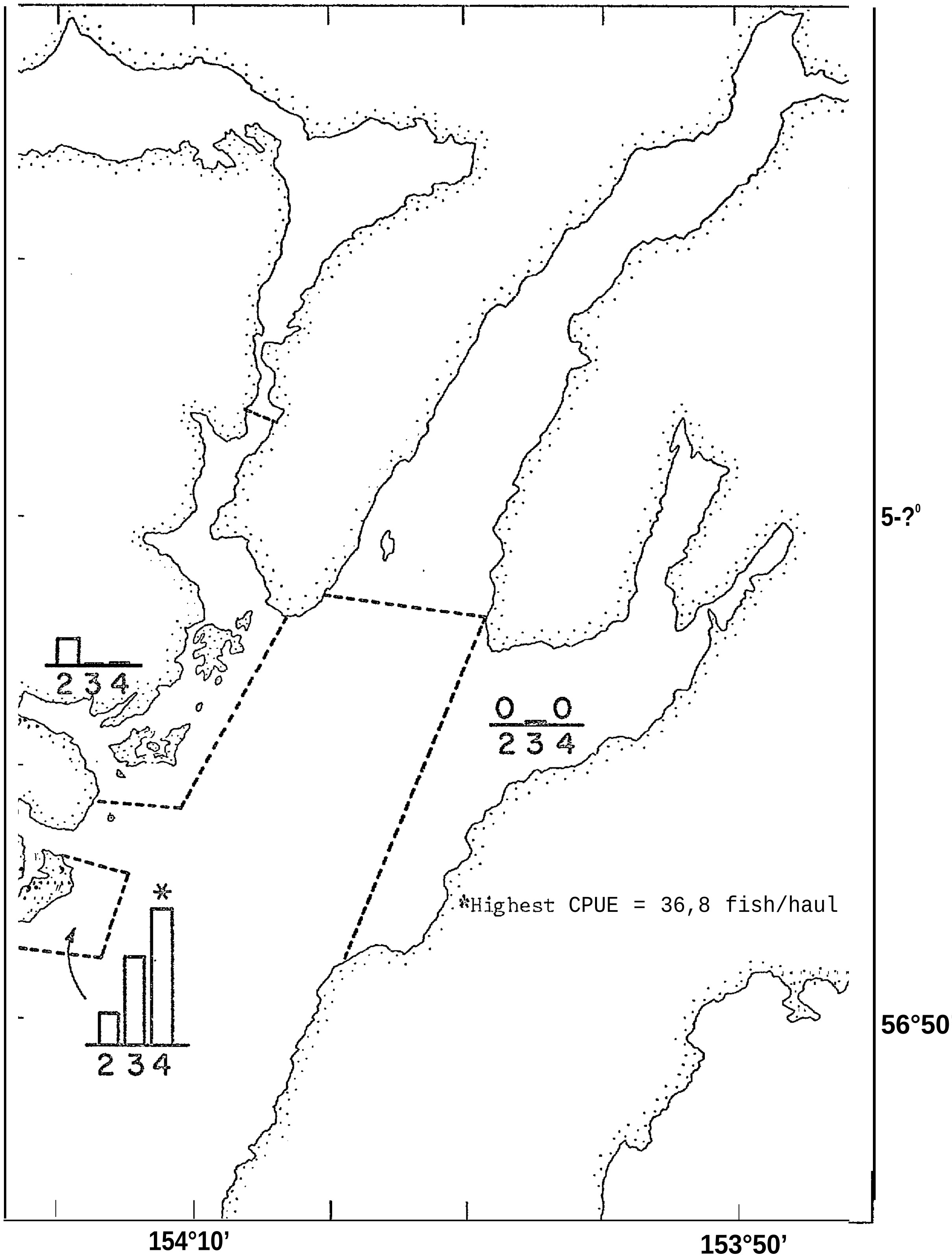
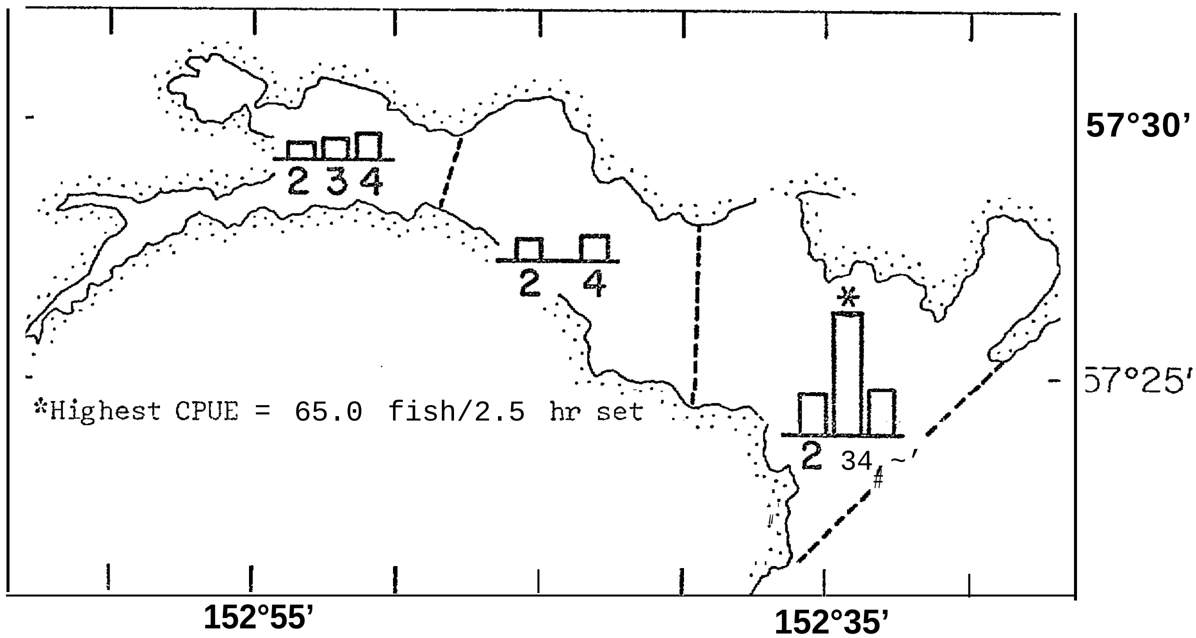


Fig. 20C. Try net CPUE of rock sole in cruises 2-4 and in various regions of Alitak Bay. The cruise numbers are indicated below the bars.



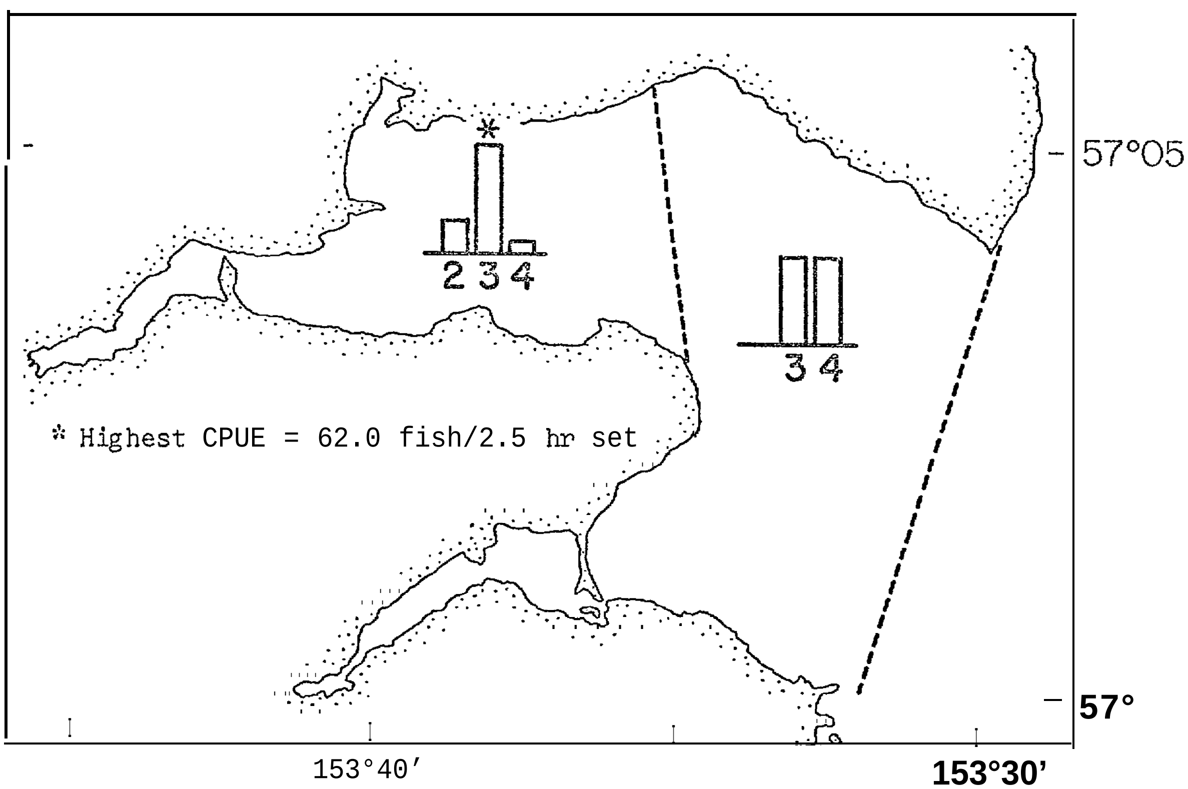


Fig. 21A & B, Trammel net CPUE of rock greenling in cruises 2-4 and various regions of Ugak Bay (A, top) and Kaiugnak Bay (B, bottom). The cruise numbers are indicated below the bars.

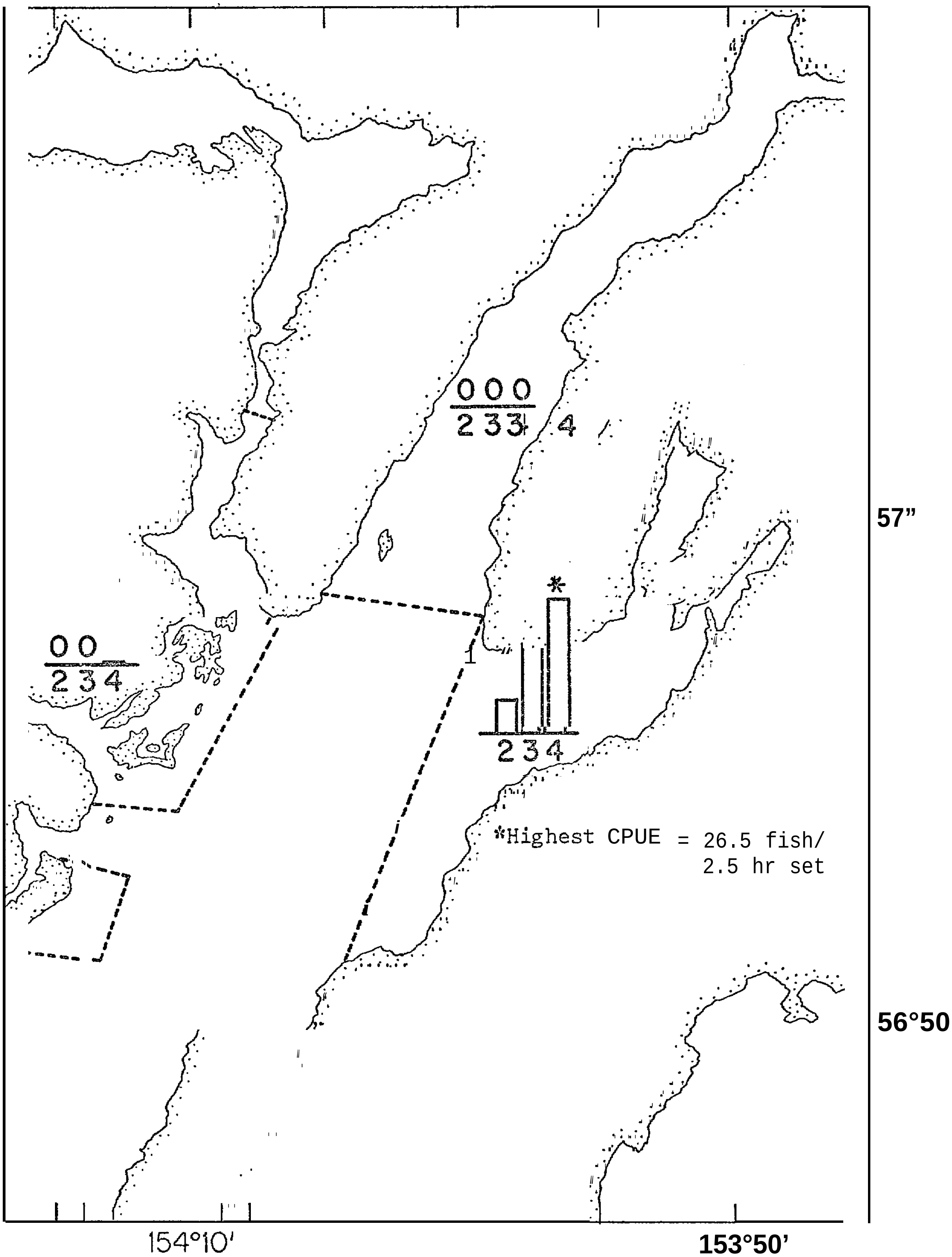
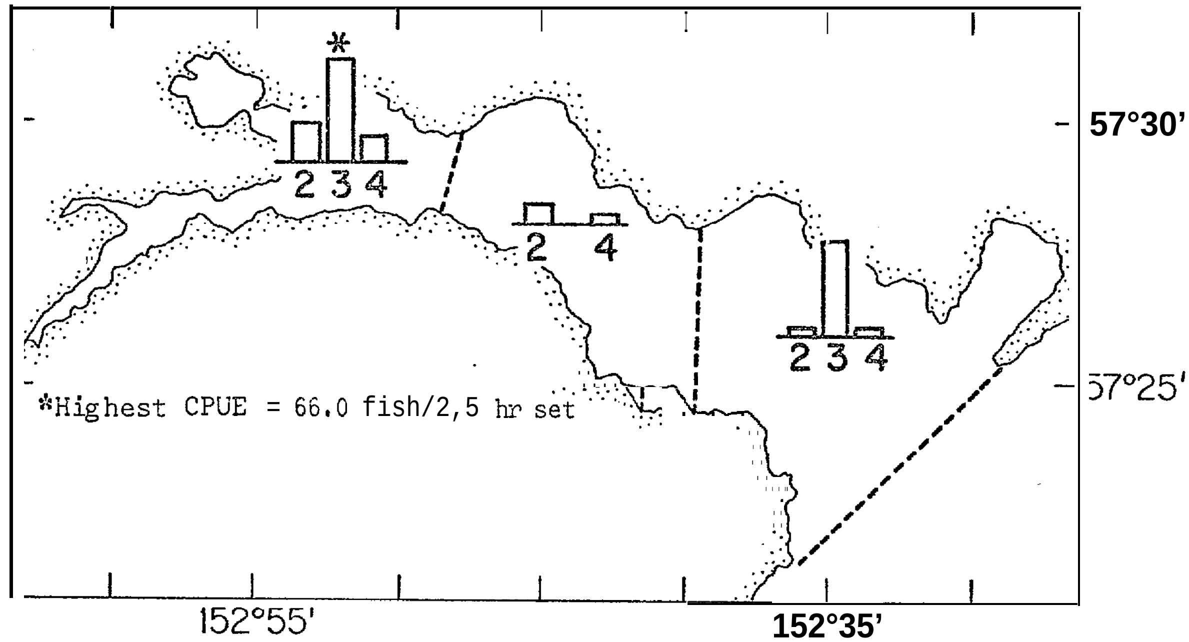


Fig. 21C. Trammel net CPUE of rock greenling in cruises 2-4 and in various regions of Alitak Bay. The cruise numbers are indicated below the bars.



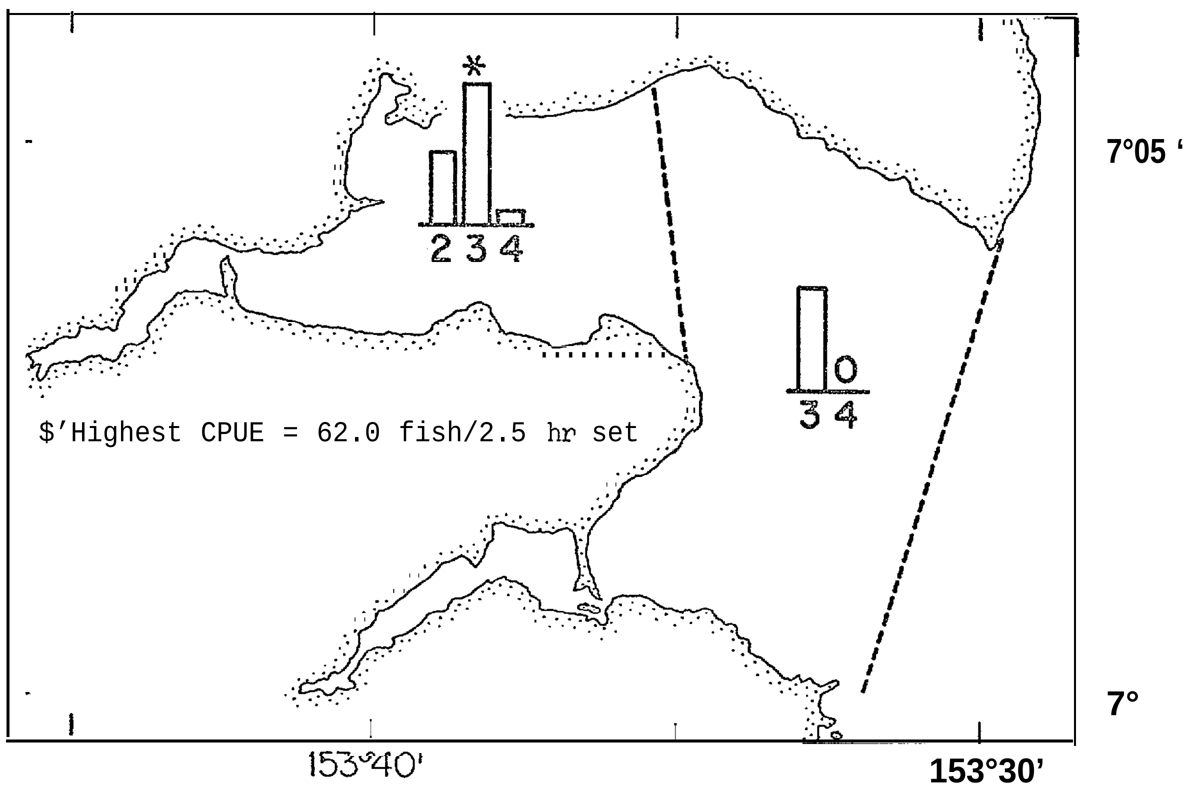


Fig. 22A & B. Trammel net CPUE ofmasked greenling in cruises 2-4 and in various regions of Ugak Bay (A, top) and Kaiugnak Bay (B, bottom). The cruise numbers are indicated below the bars.

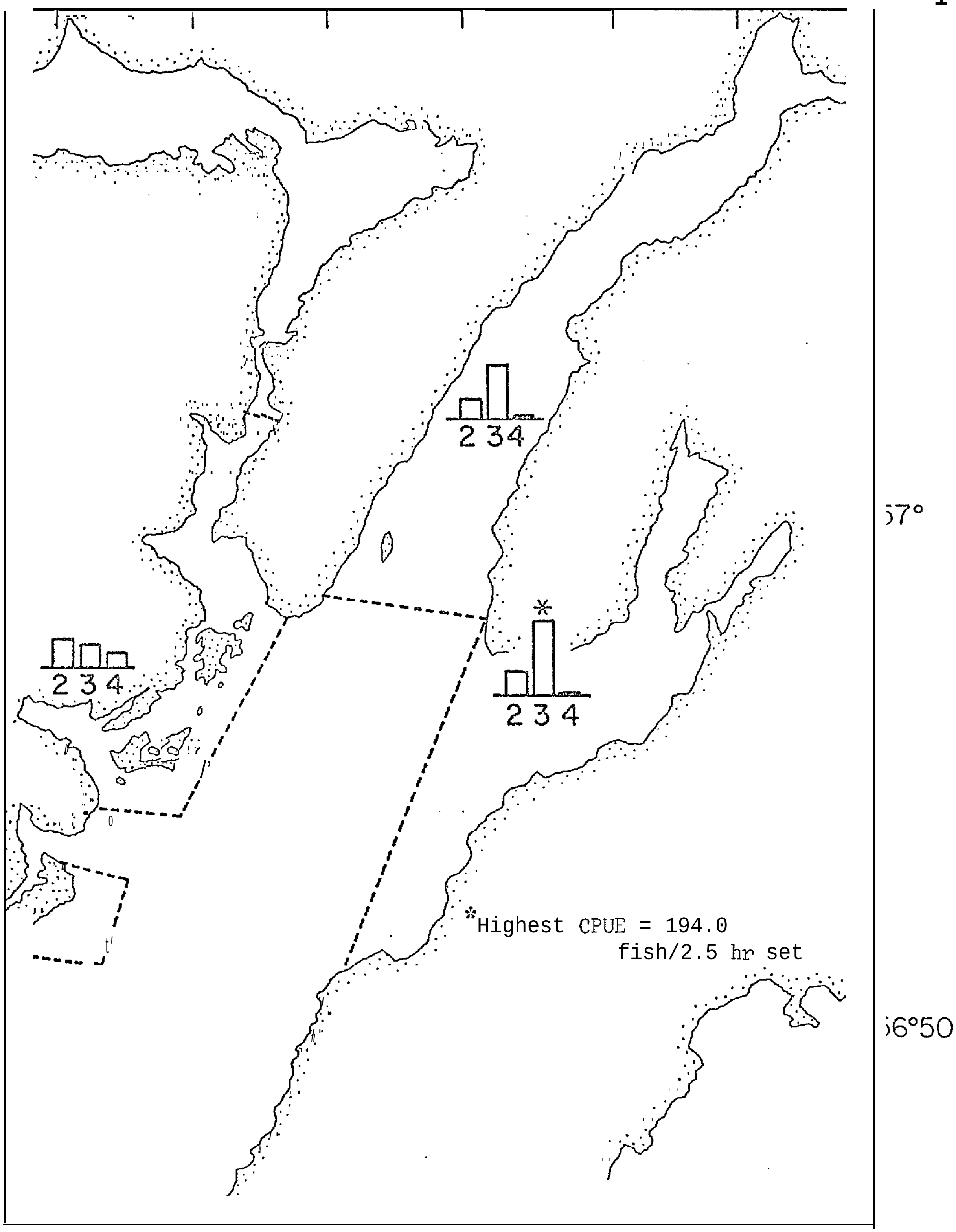


Fig. 22C. Trammel net CPUE of masked greenling in cruises 2-4 and in various regions of Alitak Bay. The cruise numbers are indicated below the bars.

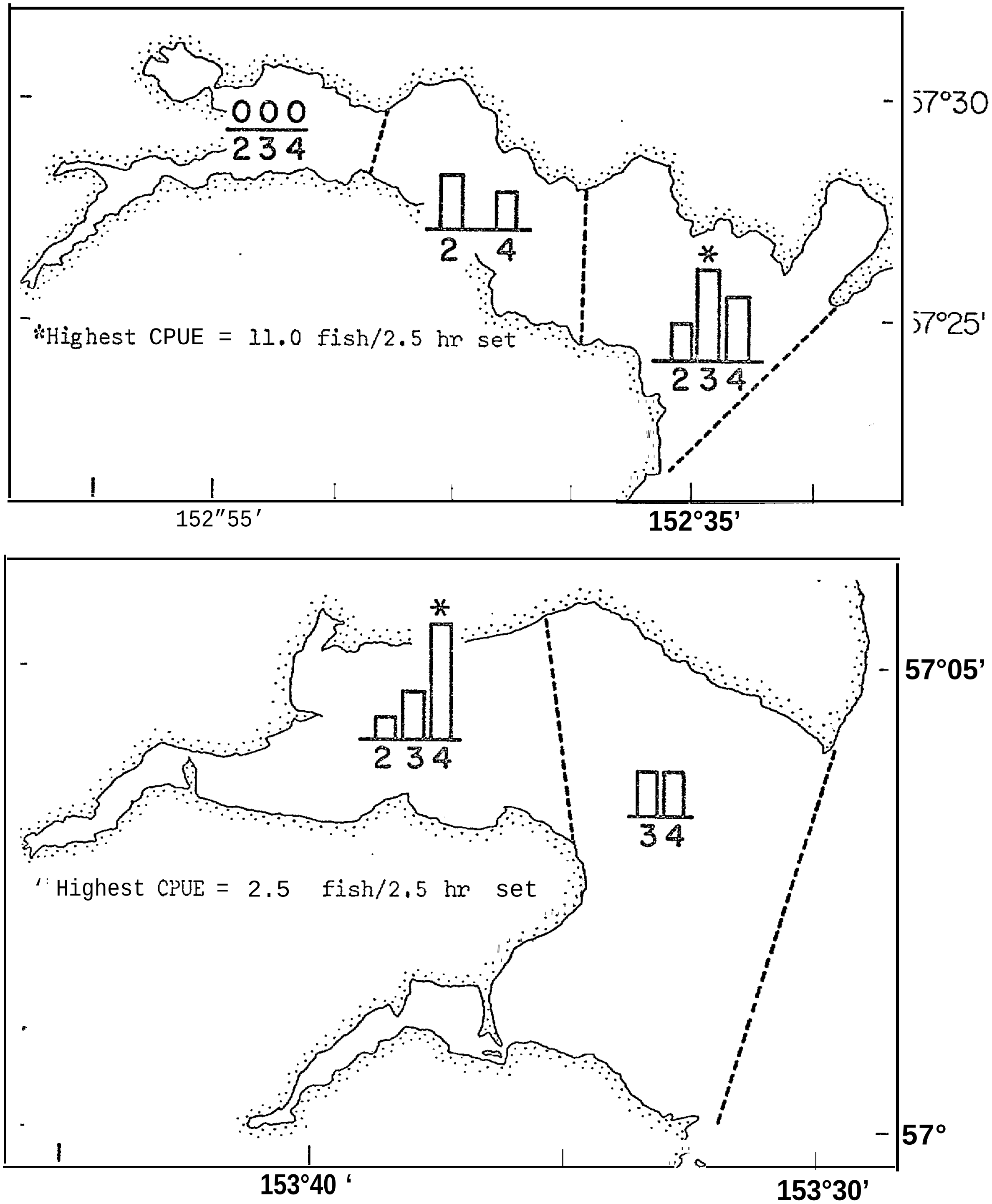


Fig . 23A & B. Trammel net CPUE of whitespotted greenling in cruises 2-4 and in various regions of Ugak Bay (A, top) and Kaiugnak Bay (B, bottom). The cruise numbers are indicated below the bars,

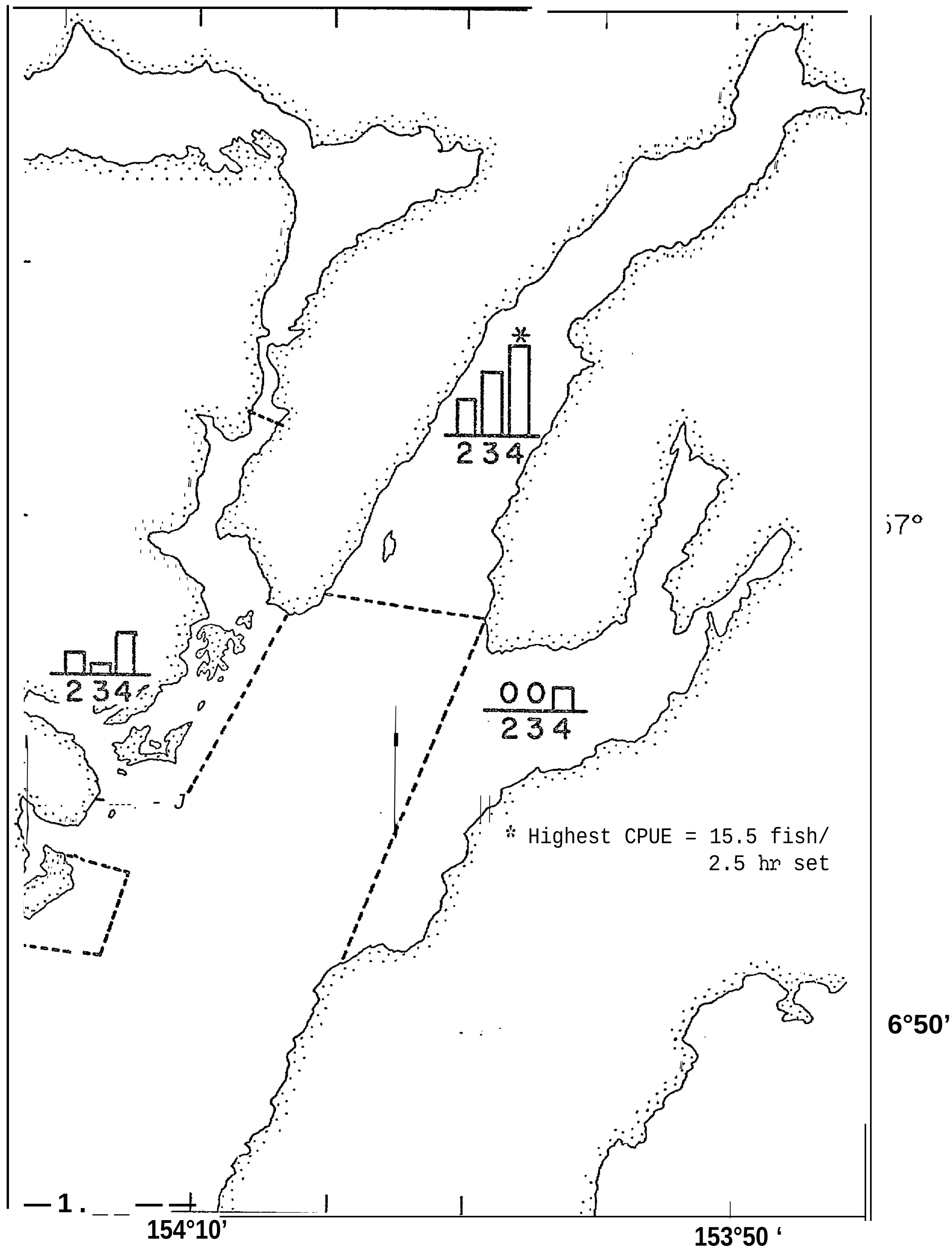


Fig. 23C. Trammel net CPUE of whitespotted greenling in cruises 2-4 and in various regions of Alitak Bay. The cruise numbers are indicated below the bars.

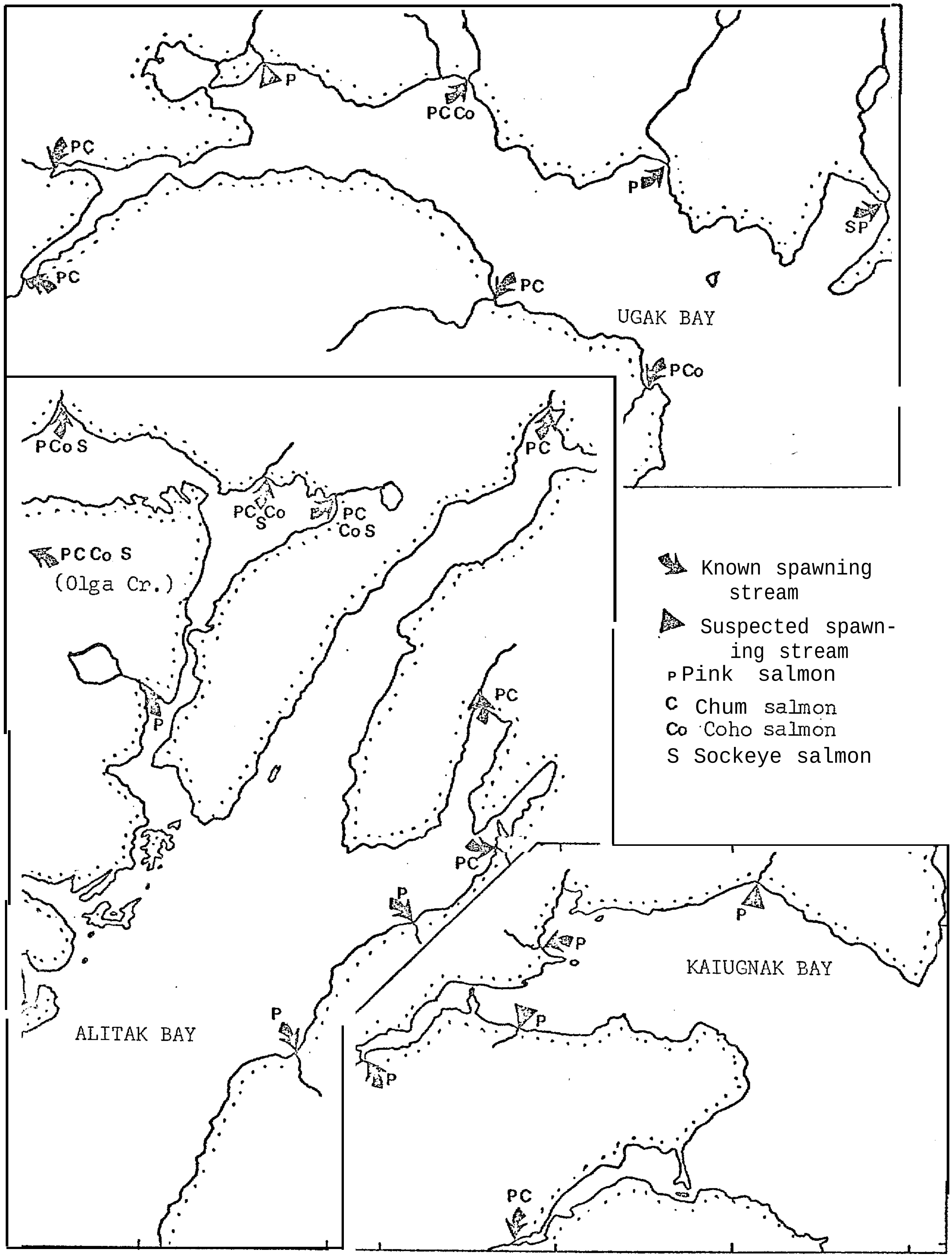


Fig.. 24. Major salmon spawning streams in the study area as found in the present study and as shown in Atkinson, Rose, and Duncan (1967).

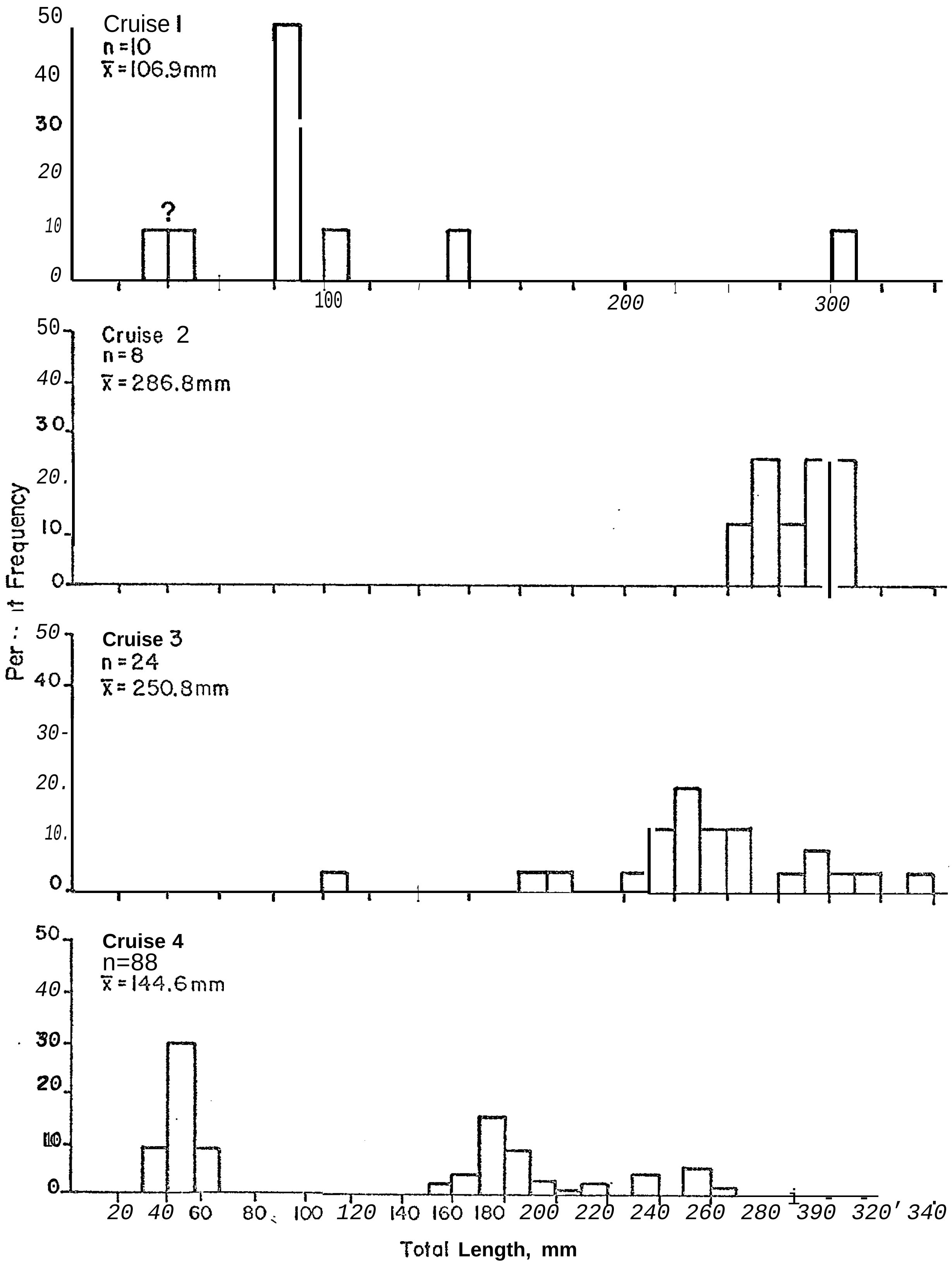
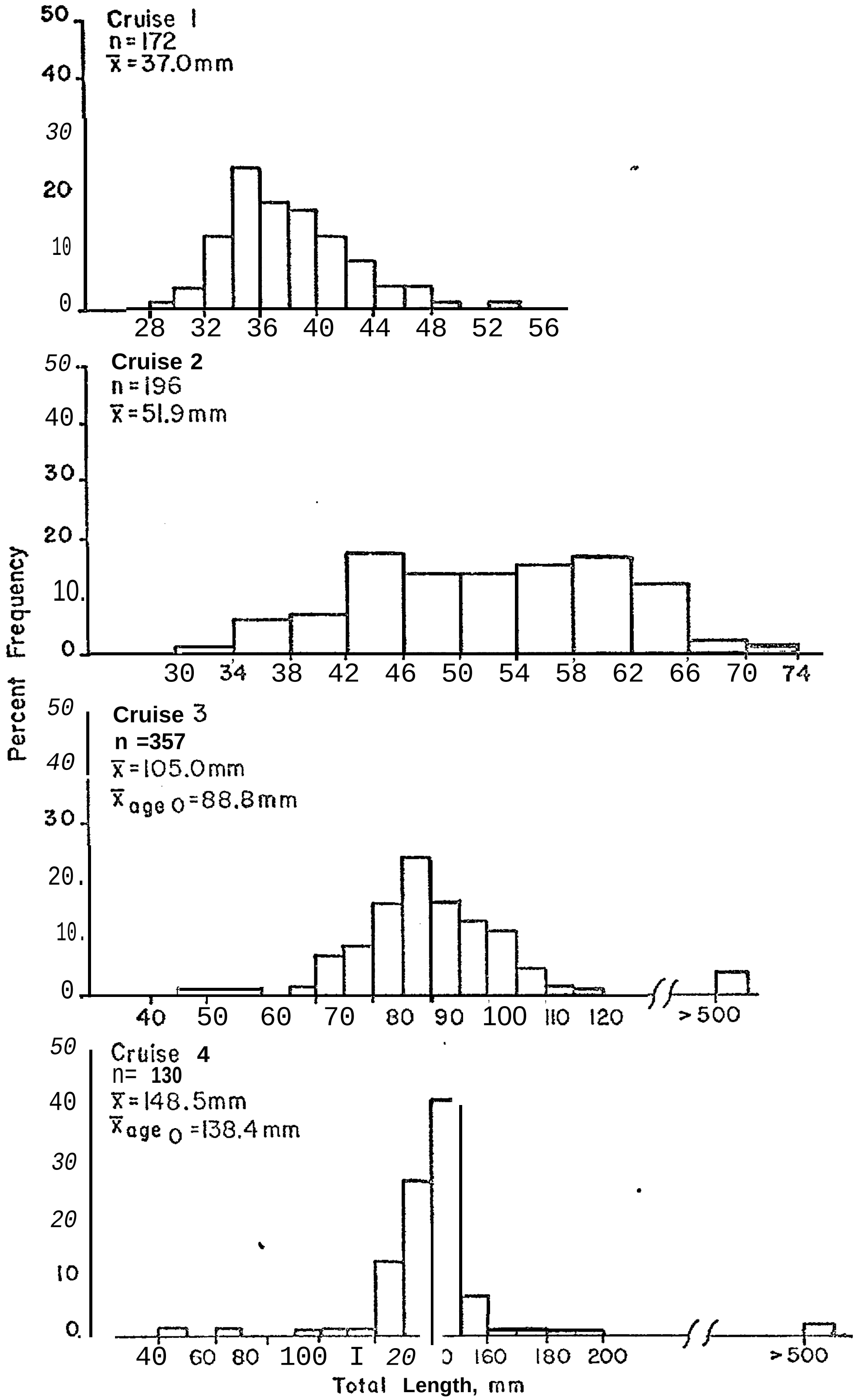


Fig. **25.** Lengths of Pacific herring, *Clupea h. pallasi*, pooled over all bays and gear types. The occurrence of fish around 40 mm in late May is dubious, and probably is a case of mistaken larval identification.



Fig, 26. Lengths of pink **salmon**, *Oncorhynchus gorbuscha*, pooled over all bays and gear types.

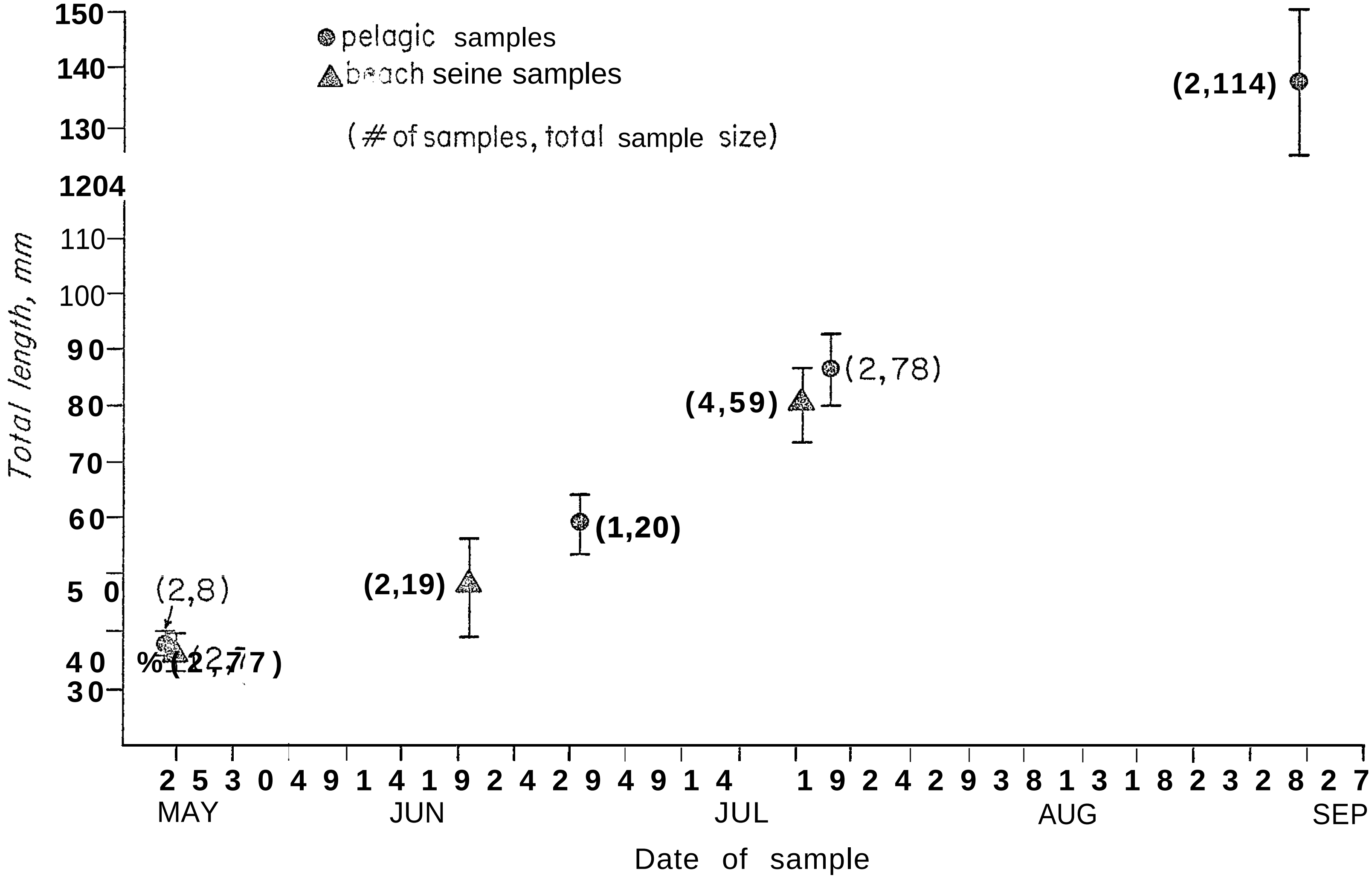


Fig. 27. Plot of grand means of total length for various intertidal and pelagic samples of juvenile pink salmon, Ugak Bay. One standard deviation is drawn on each side of the means. In the multiple sample cases, the standard deviation is Sp (the pooled-sample S.D.), and the samples were taken within two days of the date indicated.

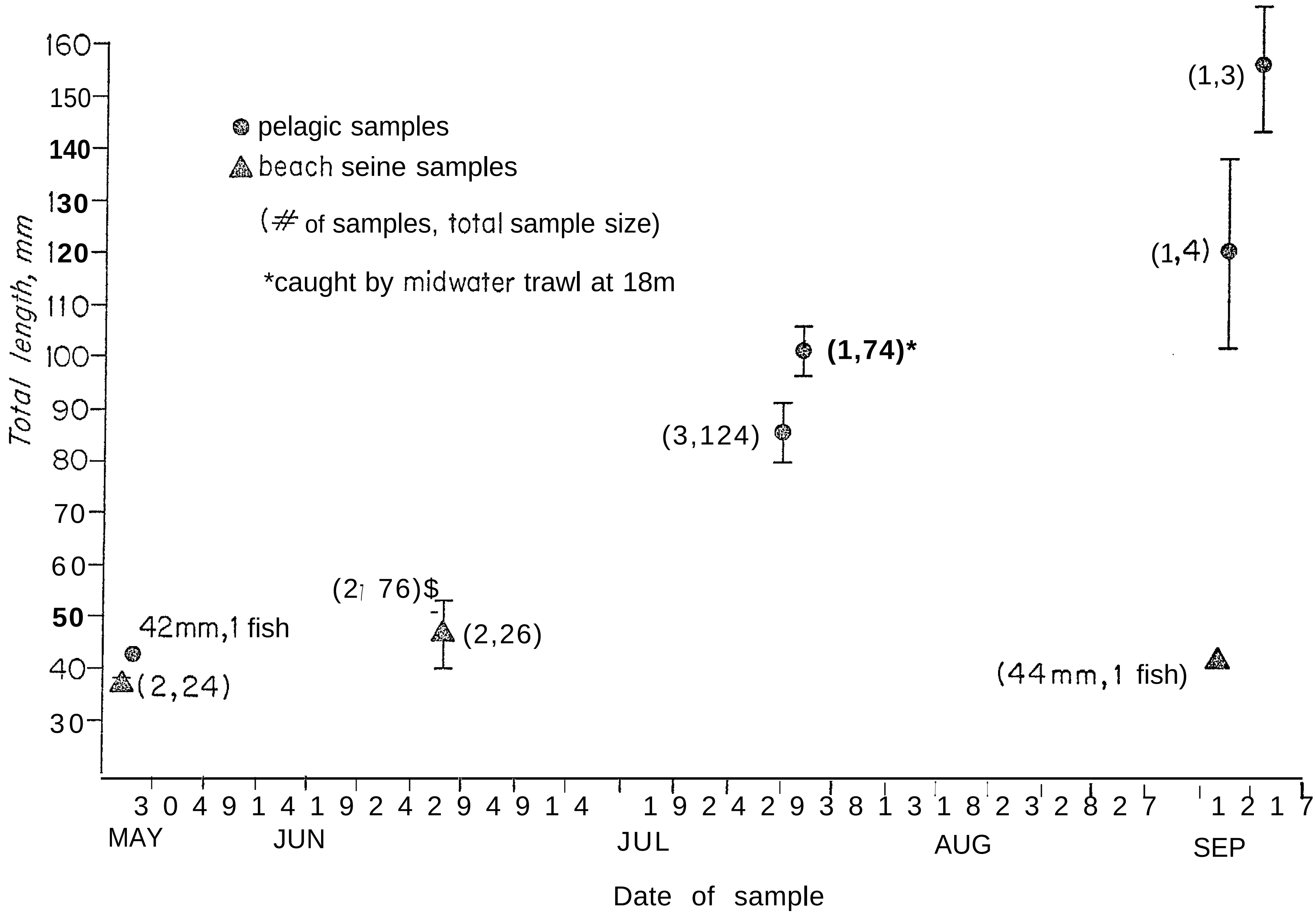
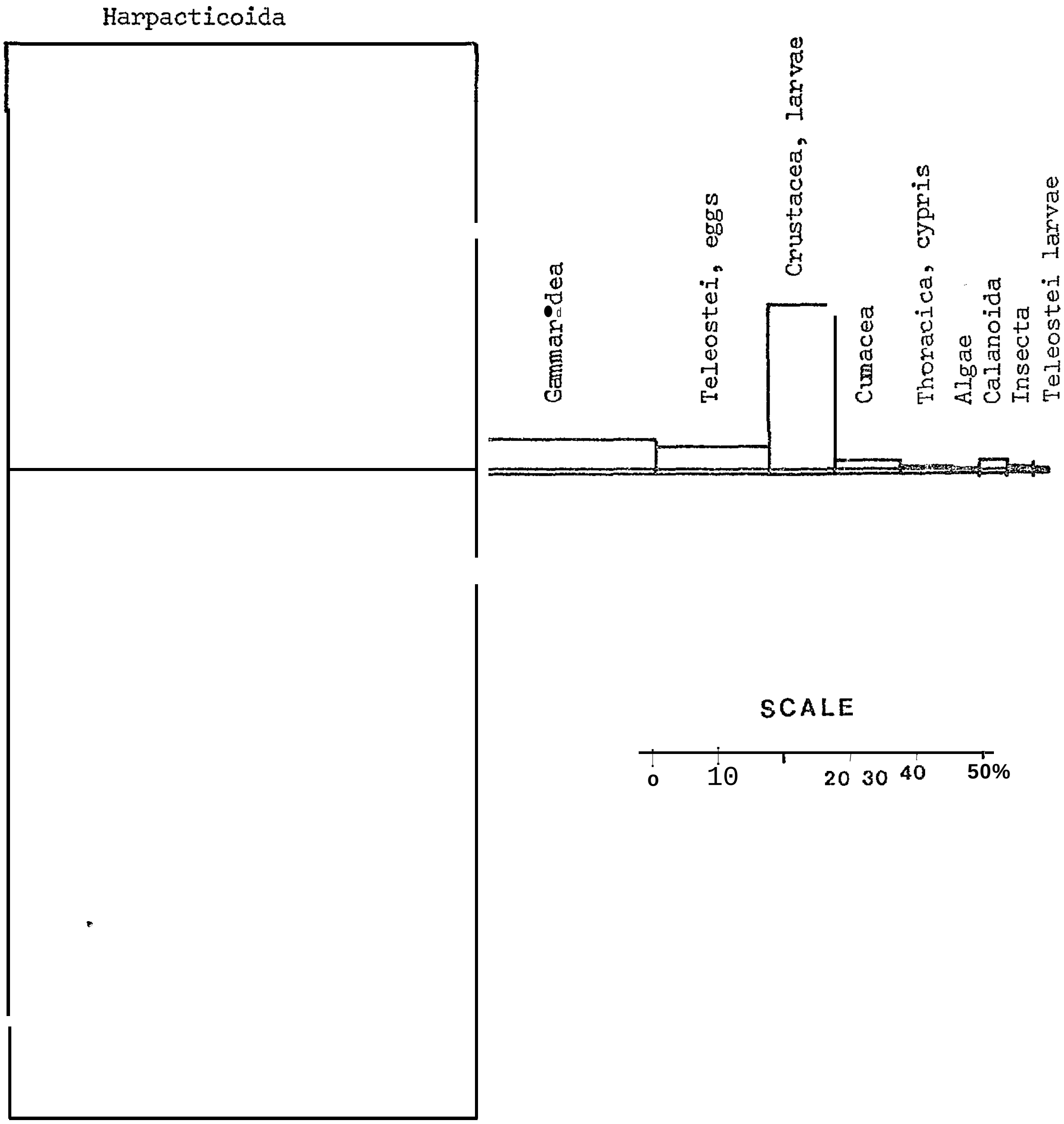


Fig. 28. Plot of grand means of total length for various intertidal and pelagic samples of juvenile pink salmon, Alitak Bay. One standard deviation is drawn on each side of the means. In the multiple sample cases, the standard deviation is Sp (the pooled sample S.D.), and the samples were taken within two days of the date indicated.



Fig, 29. Prey spectrum of 48 juvenile pink salmon caught from late May to late July in the intertidal zone of all three study bays. There were no empty stomachs, and unidentified material comprised 6.6 percent of the total weight of contents.

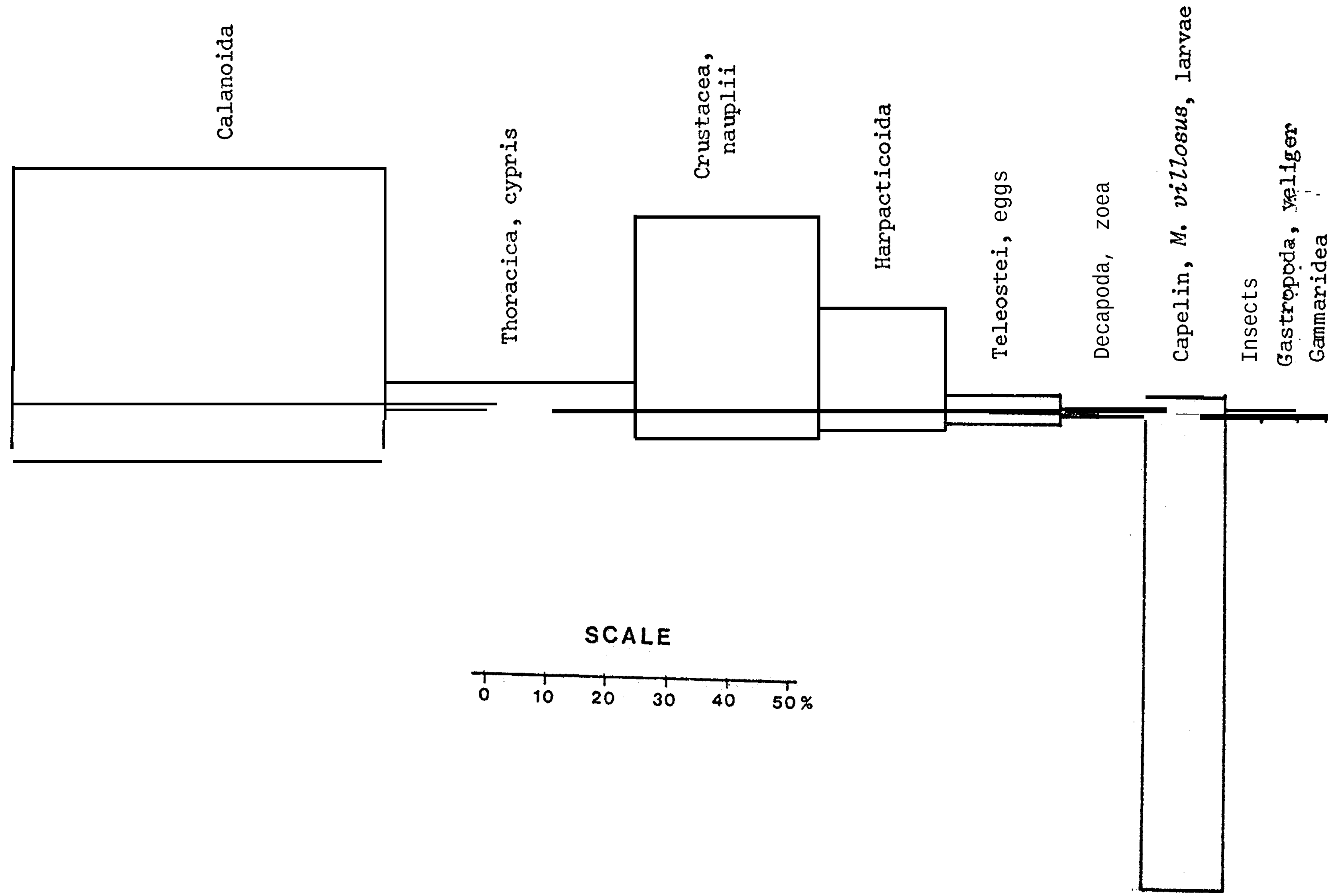


Fig. 30. Prey spectrum of 70 juvenile pink salmon caught from late June to mid-September in the epipelagic zone of Ugak and Alitak bays. There were no empty stomachs, and unidentified material comprised 21.2 percent of the total weight of contents.

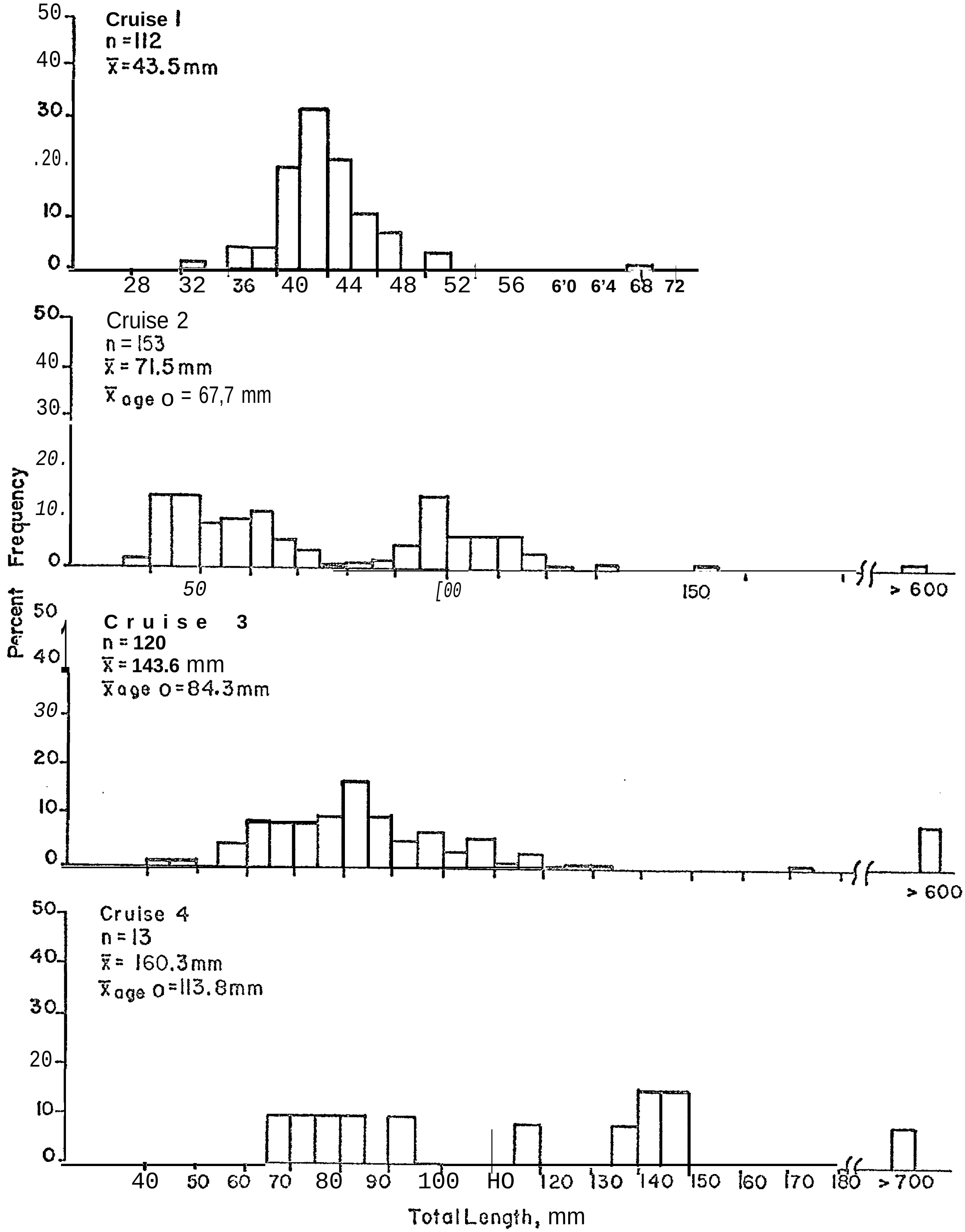


Fig. 31. Lengths of chum salmon, *Oncorhynchus keta*, pooled over all bays and gear types.

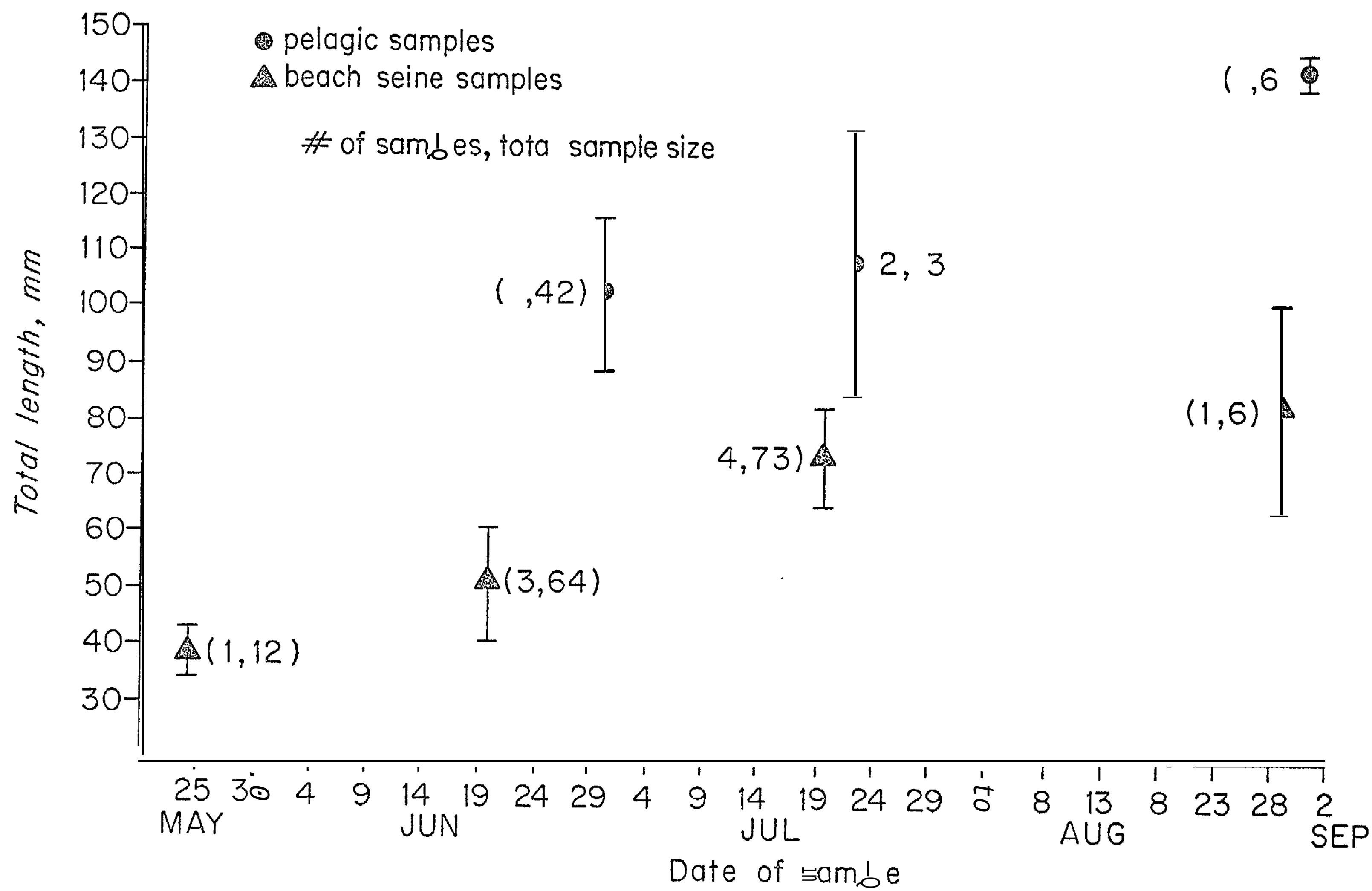


Fig. 32. Plot of grand means of total length for various intertidal and pelagic samples of juvenile chum salmon, Ugak Bay. One standard deviation is drawn on each side of the means. In the multiple sample cases, the standard deviation is Sp (pooled-sample S.D.), and the samples were taken within two days of the date indicated.

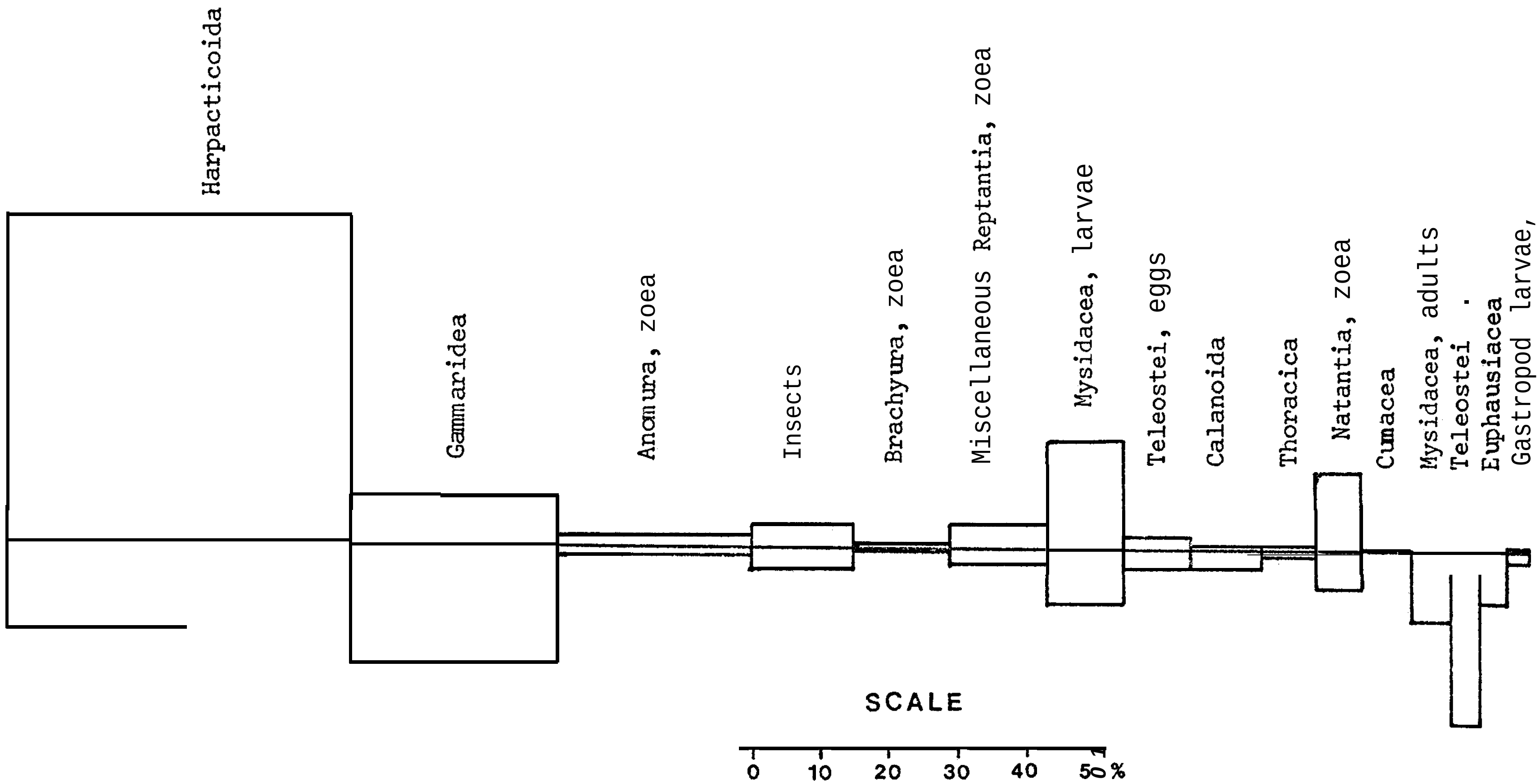


Fig. 33. Prey spectrum of 72 juvenile chum salmon (13 from pelagic zone, 59 from intertidal zone), collected from late May to late July in Ugak and Alitak bays. There were no empty stomachs, and unidentified material comprised 47.6 percent of the total weight of contents.

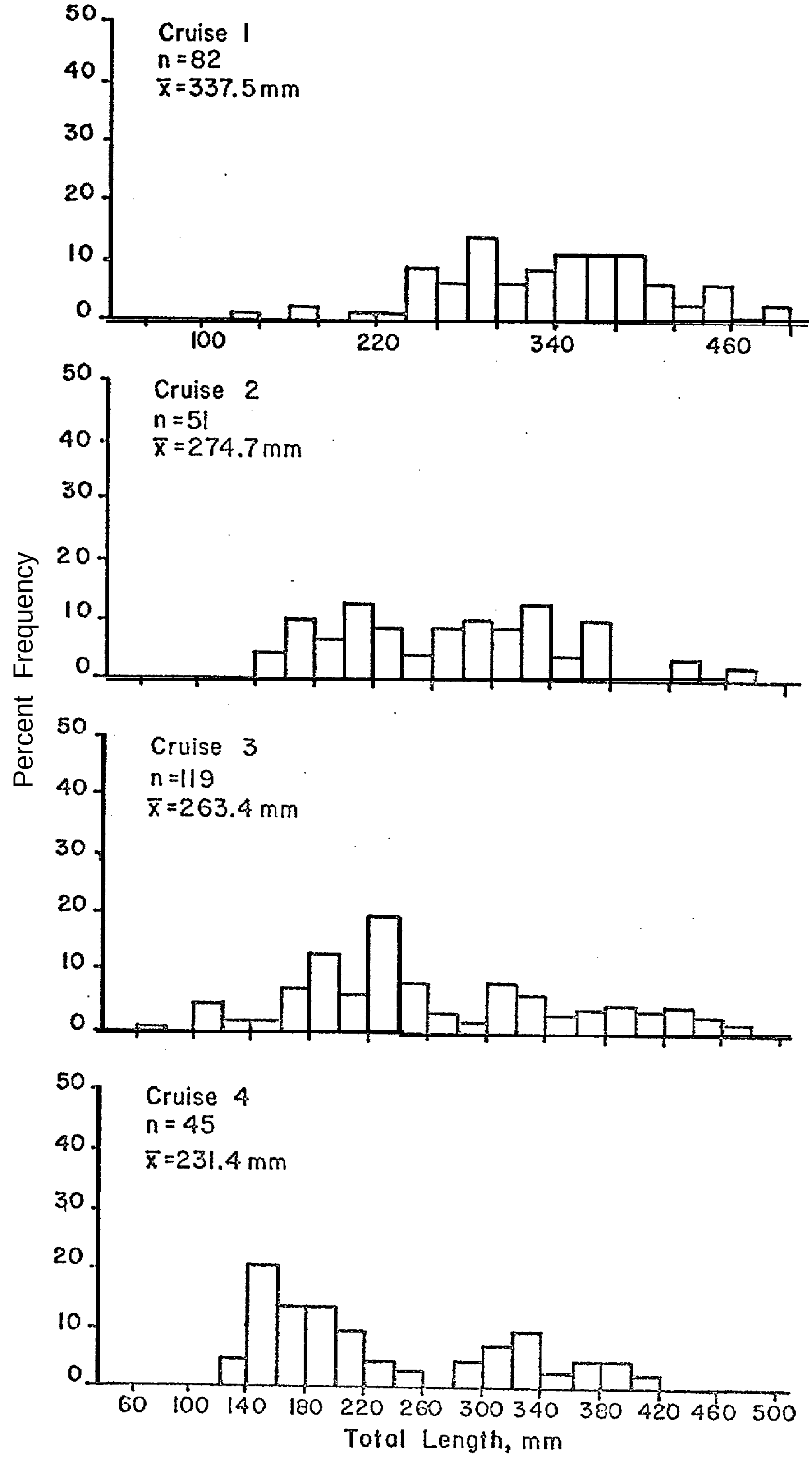
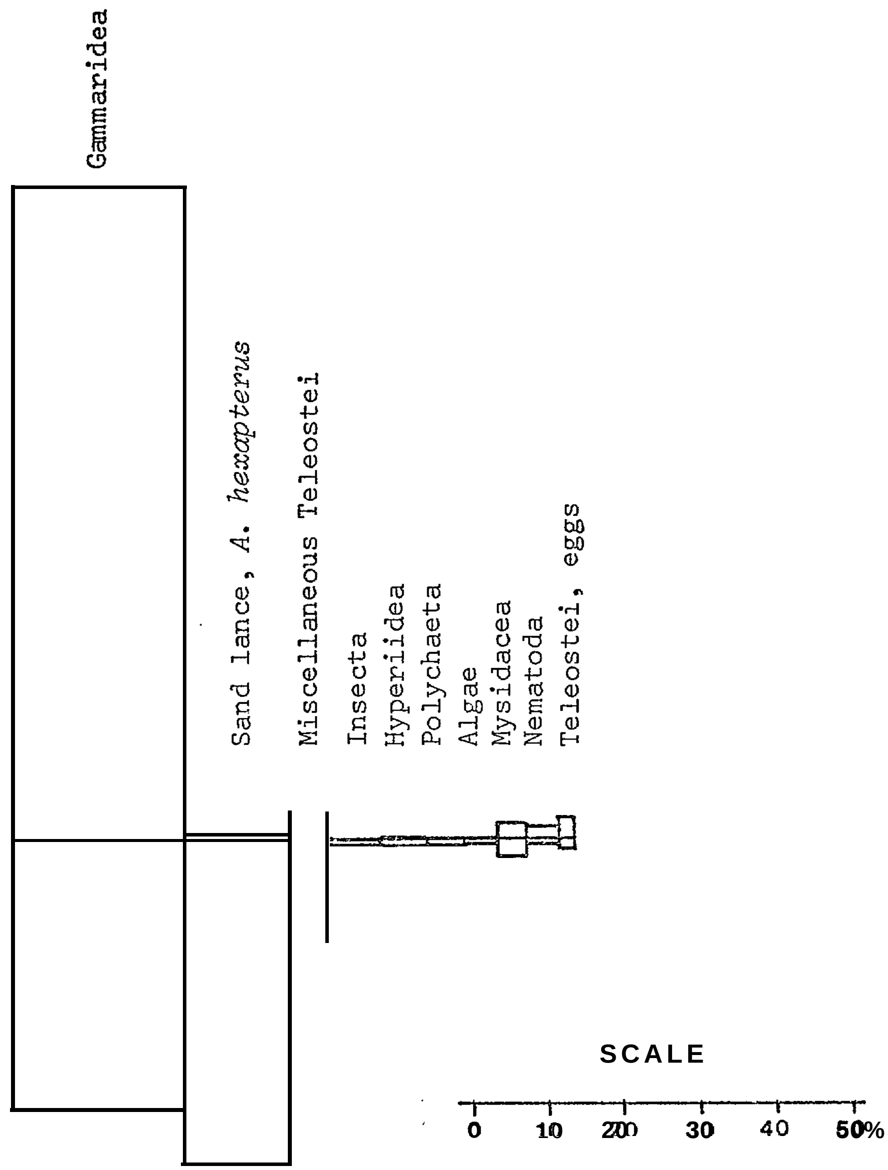


Fig. 34. Lengths of Dolly Varden, *Salvelinus malma*, pooled over all bays and gear types.



Fig, 35. Prey spectrum of 34 Dolly Varden, pooled over all bays and cruises. There was 1 empty stomach, and unidentified material comprised 30.0 percent of the total weight of contents.

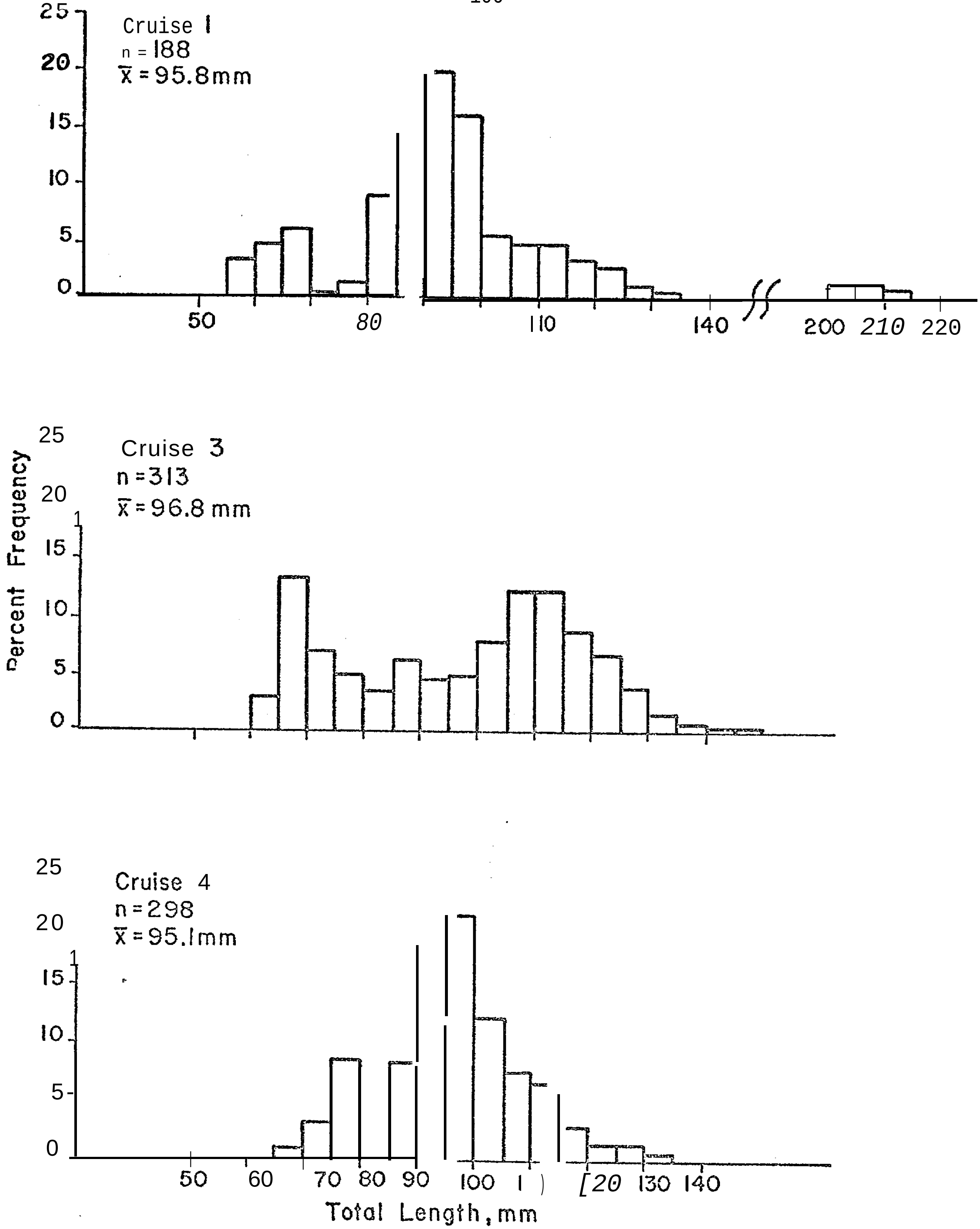


Fig. 36. Lengths of capelin, *Mallotus villosus*, caught by the mid-water trawl, pooled over all bays.

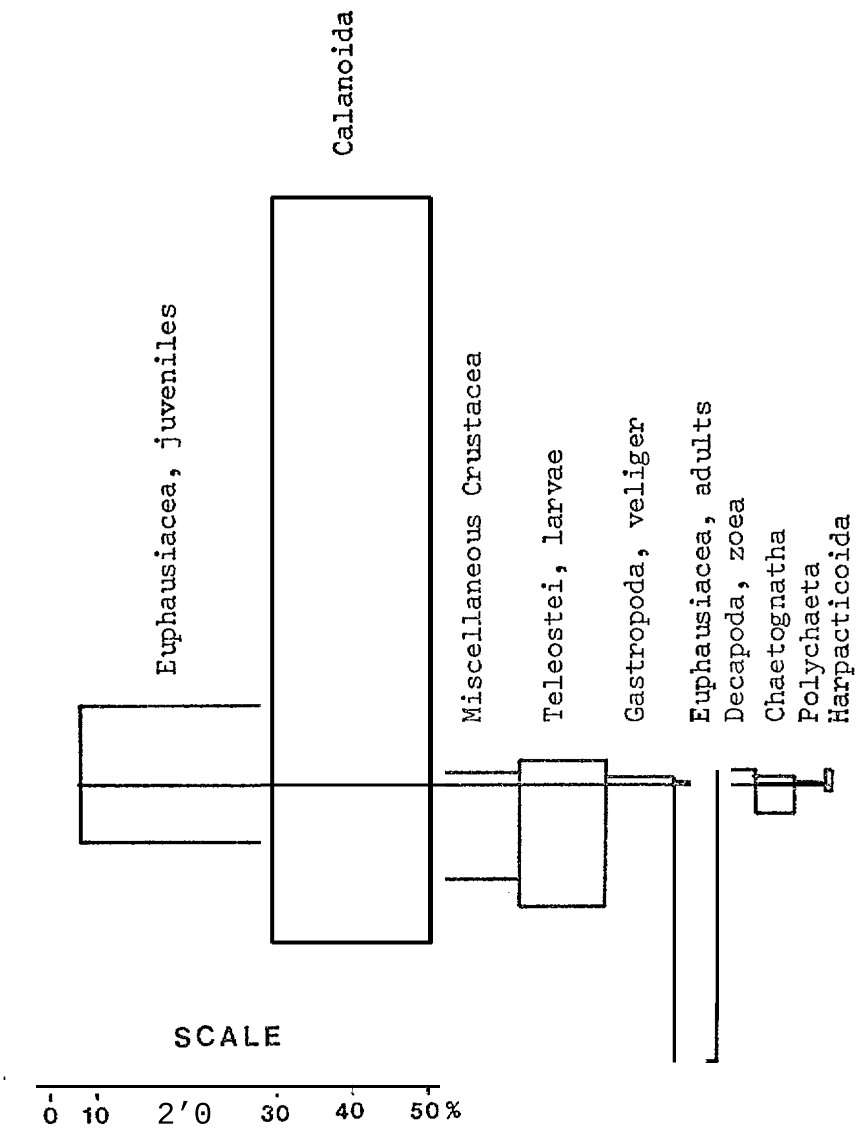


Fig. 37. Frey spectrum of 83 pelagic capelin caught in Alitak Bay in late May, and in Ugak Bay in the last three cruises. There were 2 empty stomachs, and unidentified material comprised 56.4 percent of total weight of contents.

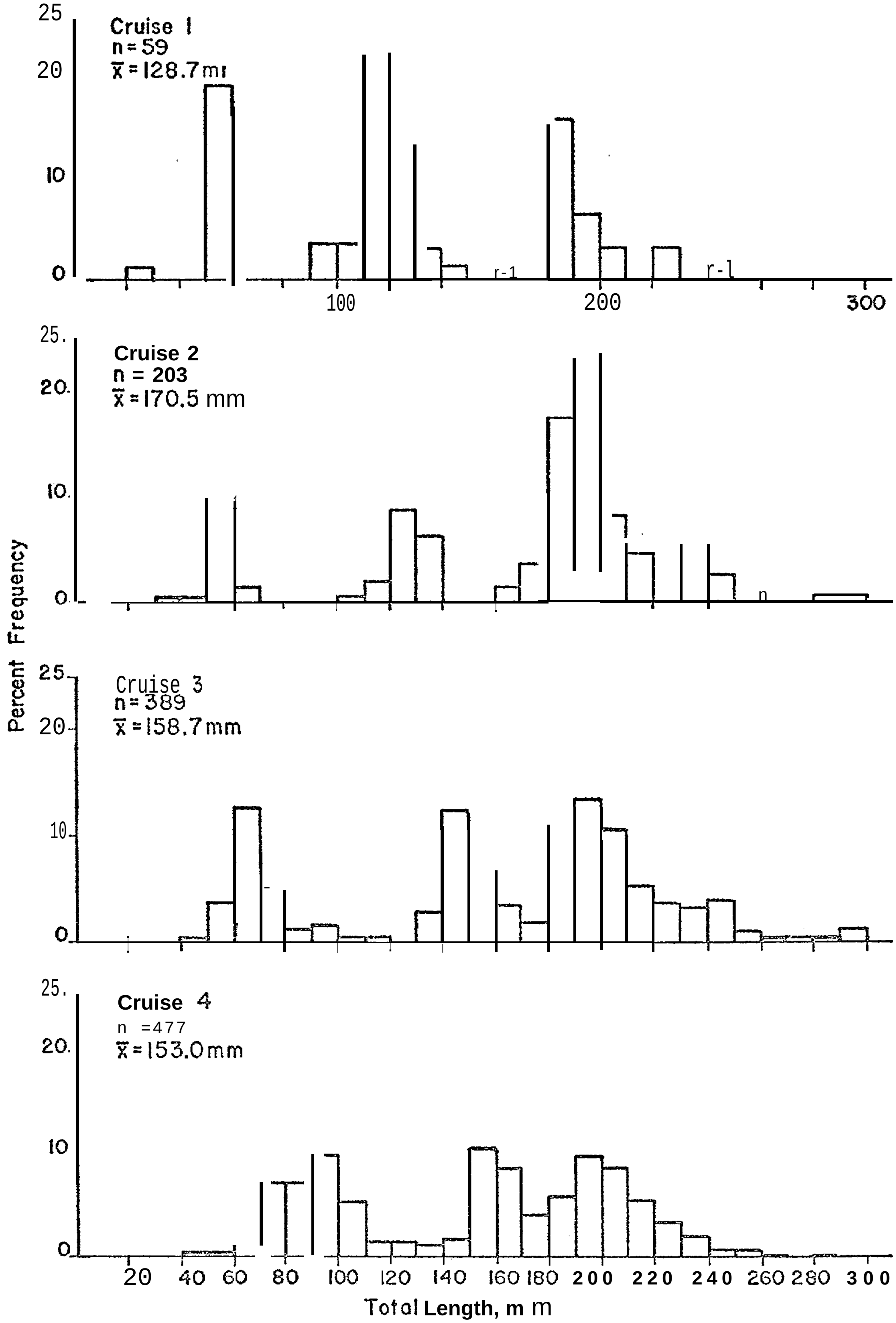


Fig. 38, Lengths of masked greenling, *Hexagrammos octogrammus*, pooled over all bays and gear types.

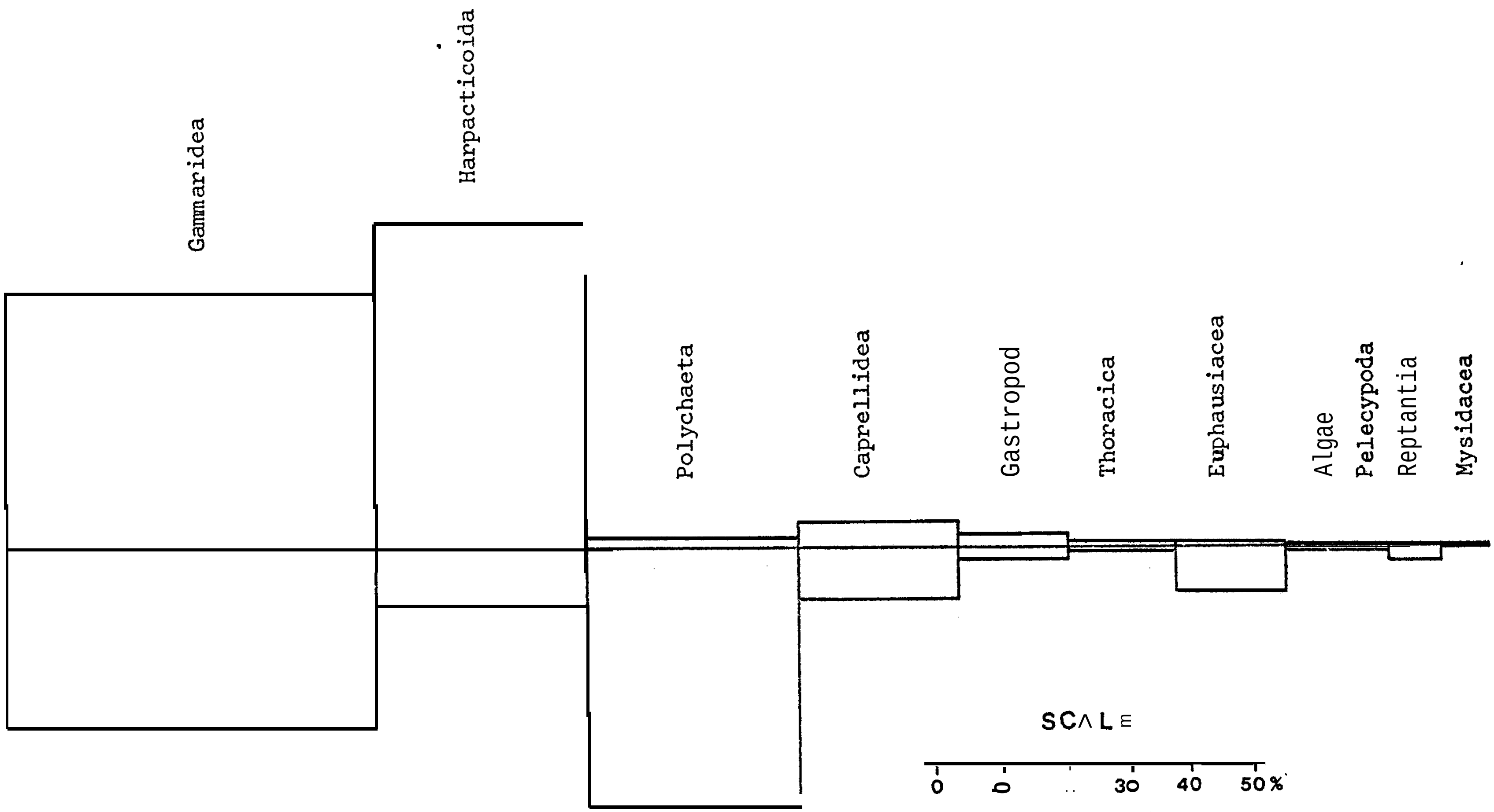


Fig. 39. Prey spectrum of 12 juvenile masked greenling caught in the nearshore zone from Alitak and Kaiugnak bays. There were no empty stomachs, and unidentified material comprised 42.0 percent of total weight of contents.

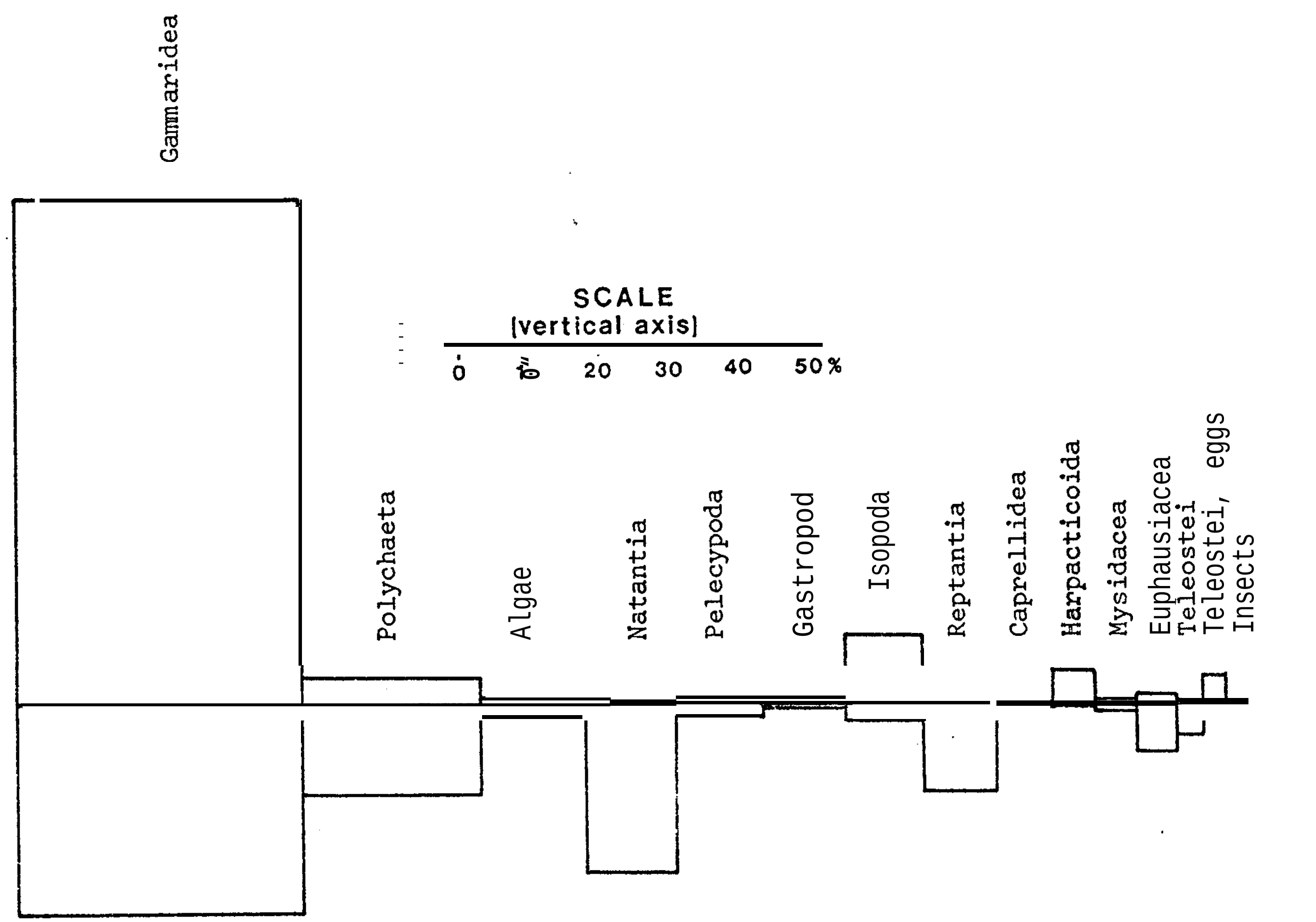


Fig. 40. Prey spectrum of 97 adult masked greenling, pooled over all bays and gear types. 1 mm = 2 percent for frequency of occurrence (horizontal axis). There were no empty stomachs, and unidentified material comprised 32.8 percent of total weight of contents.

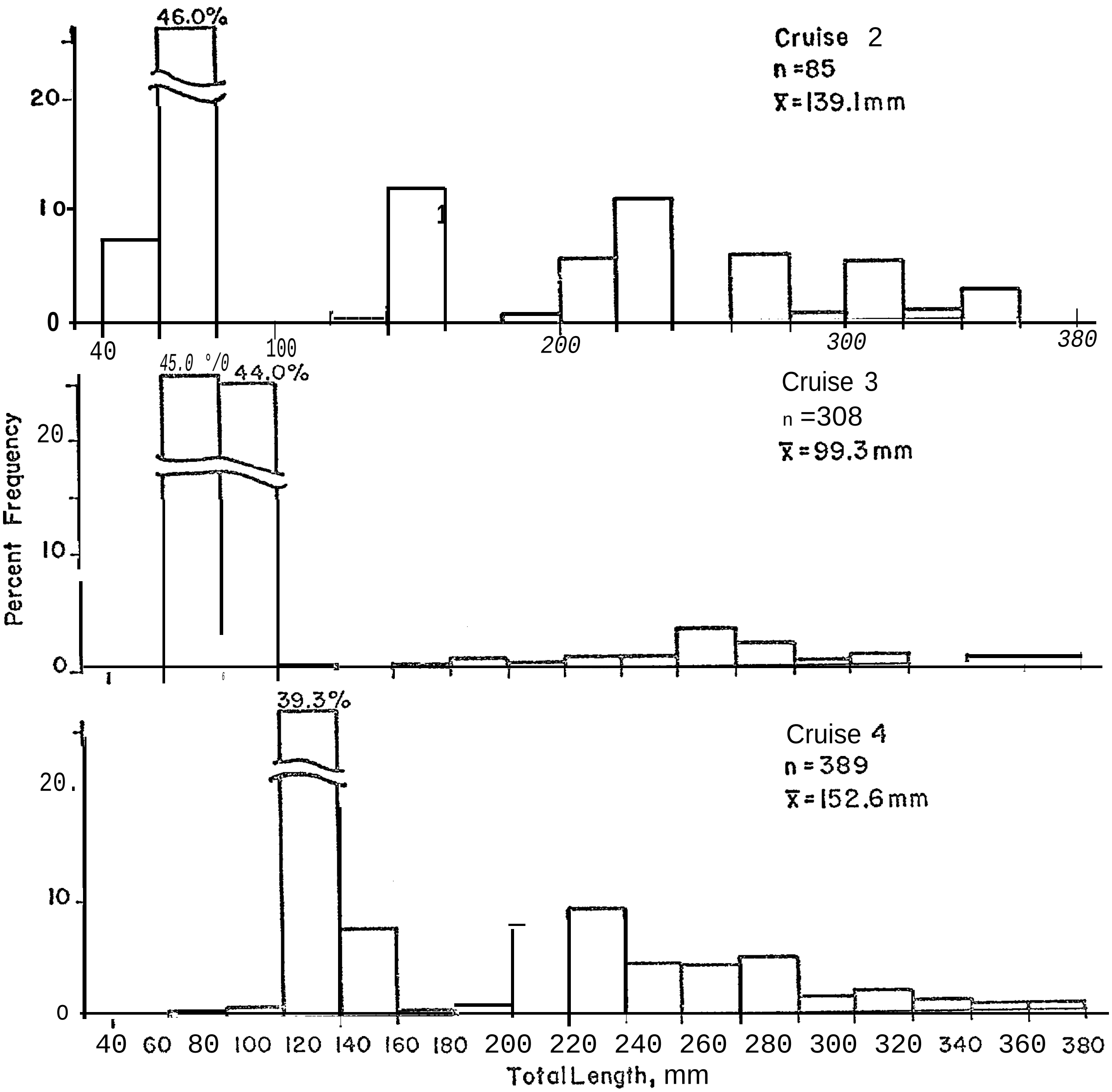


Fig . 41. Lengths of whitespotted greenling, *Hexagrammos stelleri*, pooled over all bays and gear types.

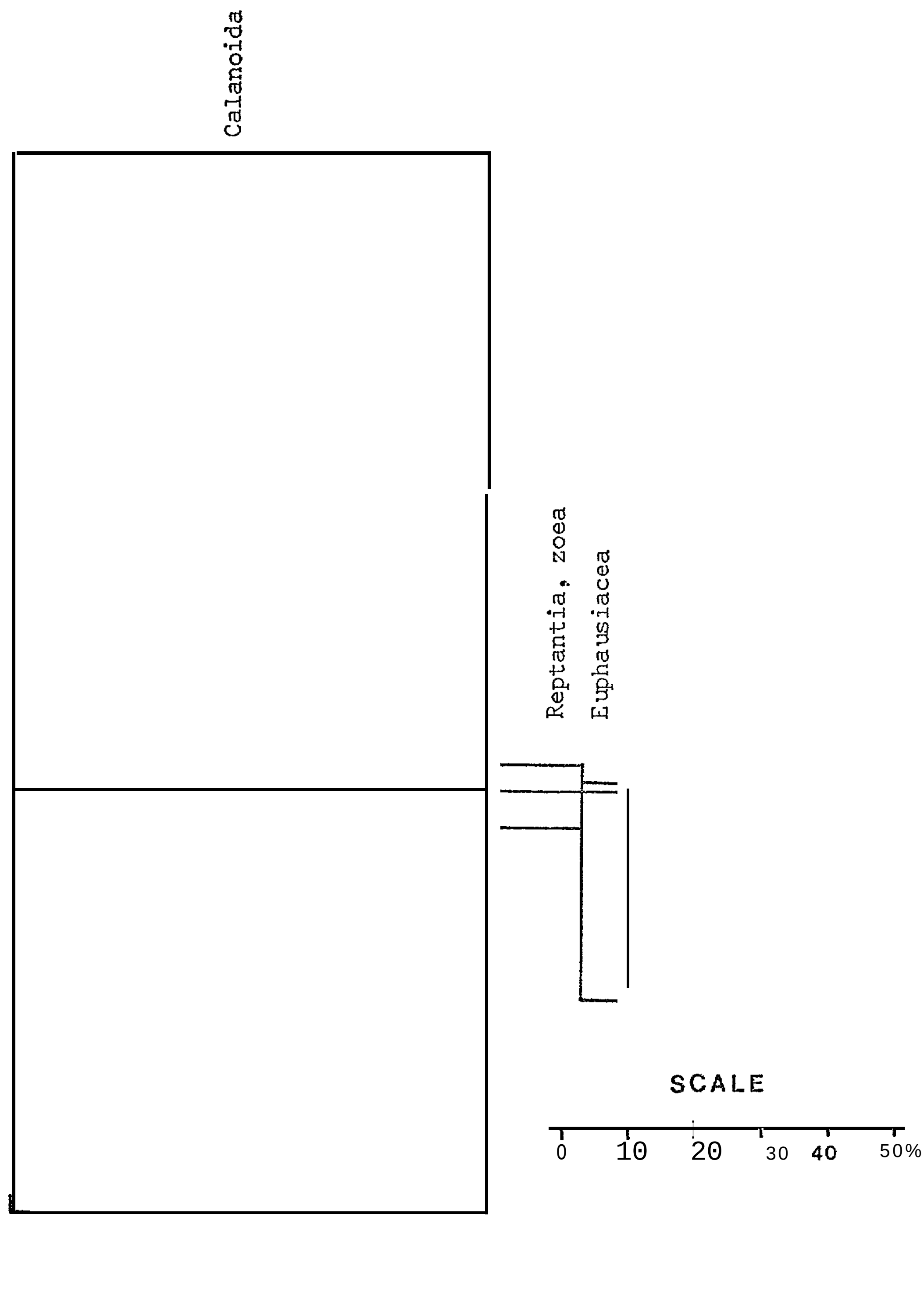


Fig . 42. Prey spectrum of 14 pelagic juvenile white-spotted greenling collected from Alitak Bay in late June. There were no empty stomachs, and unidentified material comprised 41.0 percent of total weight of contents.

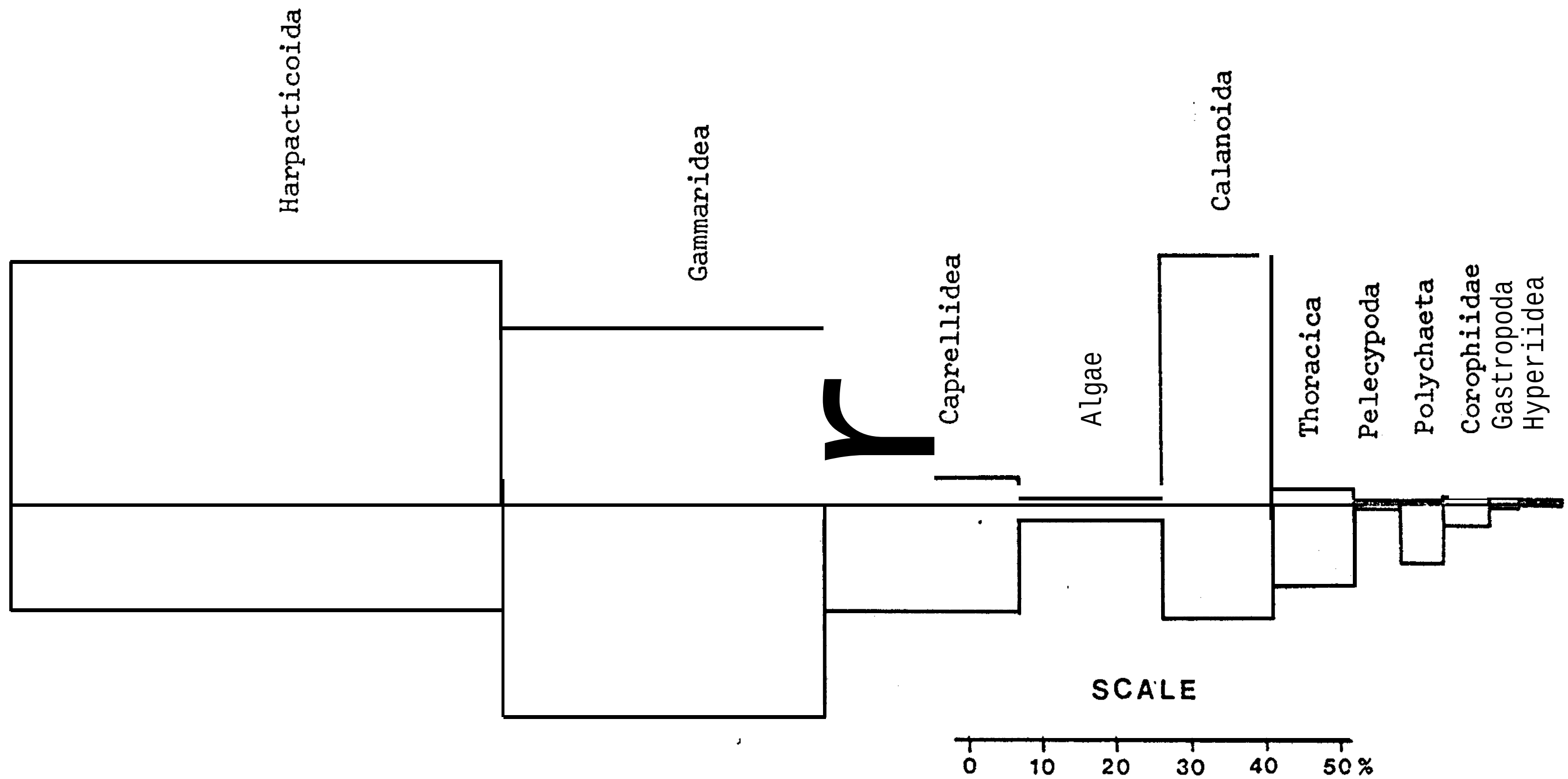


Fig. 43. Prey spectrum of 47 juvenile whitespotted greenling caught in the intertidal zone of Alitak Bay in early August. There were no empty stomachs; and unidentified material comprised 50.4 percent of total weight of contents.

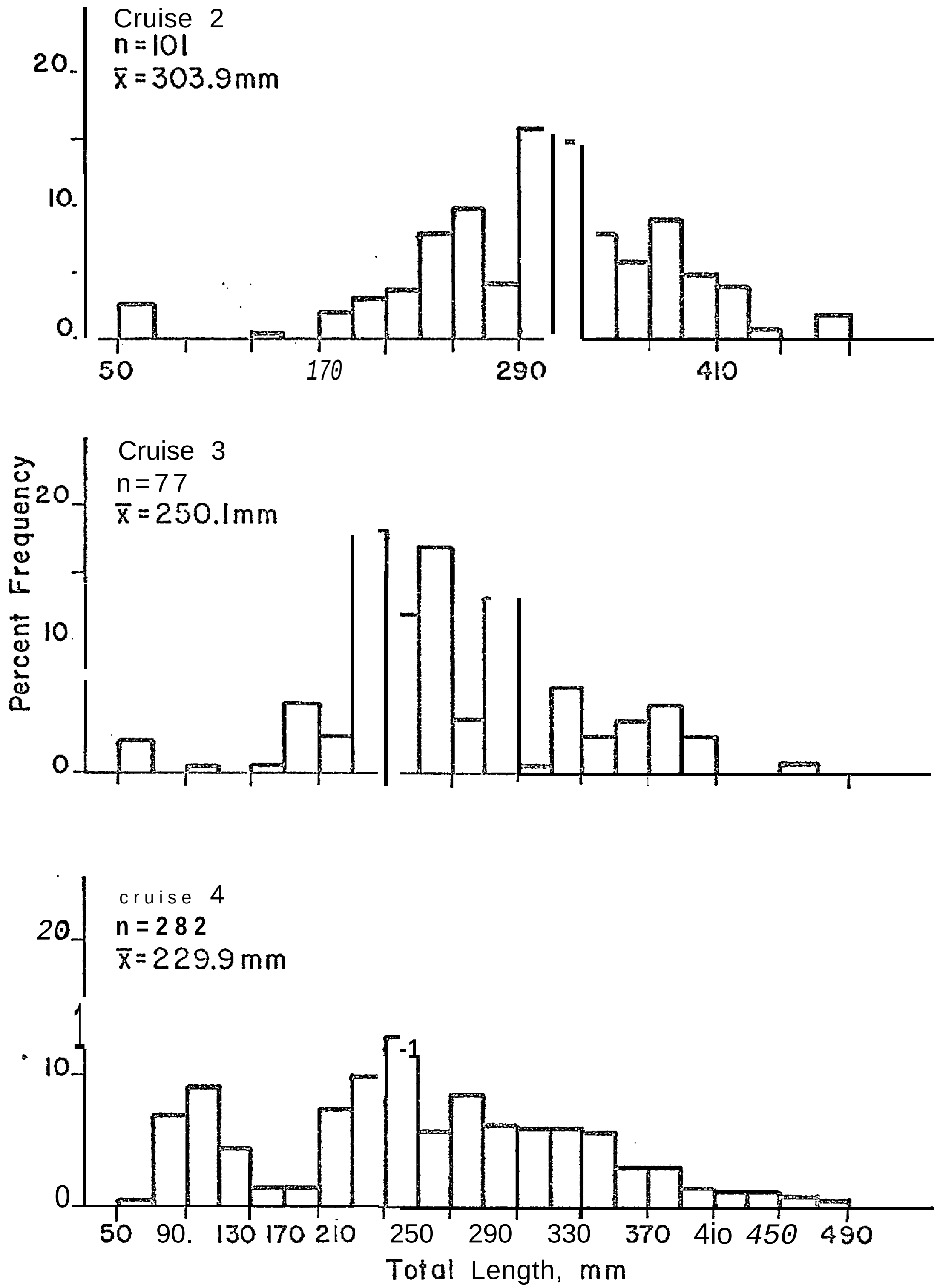
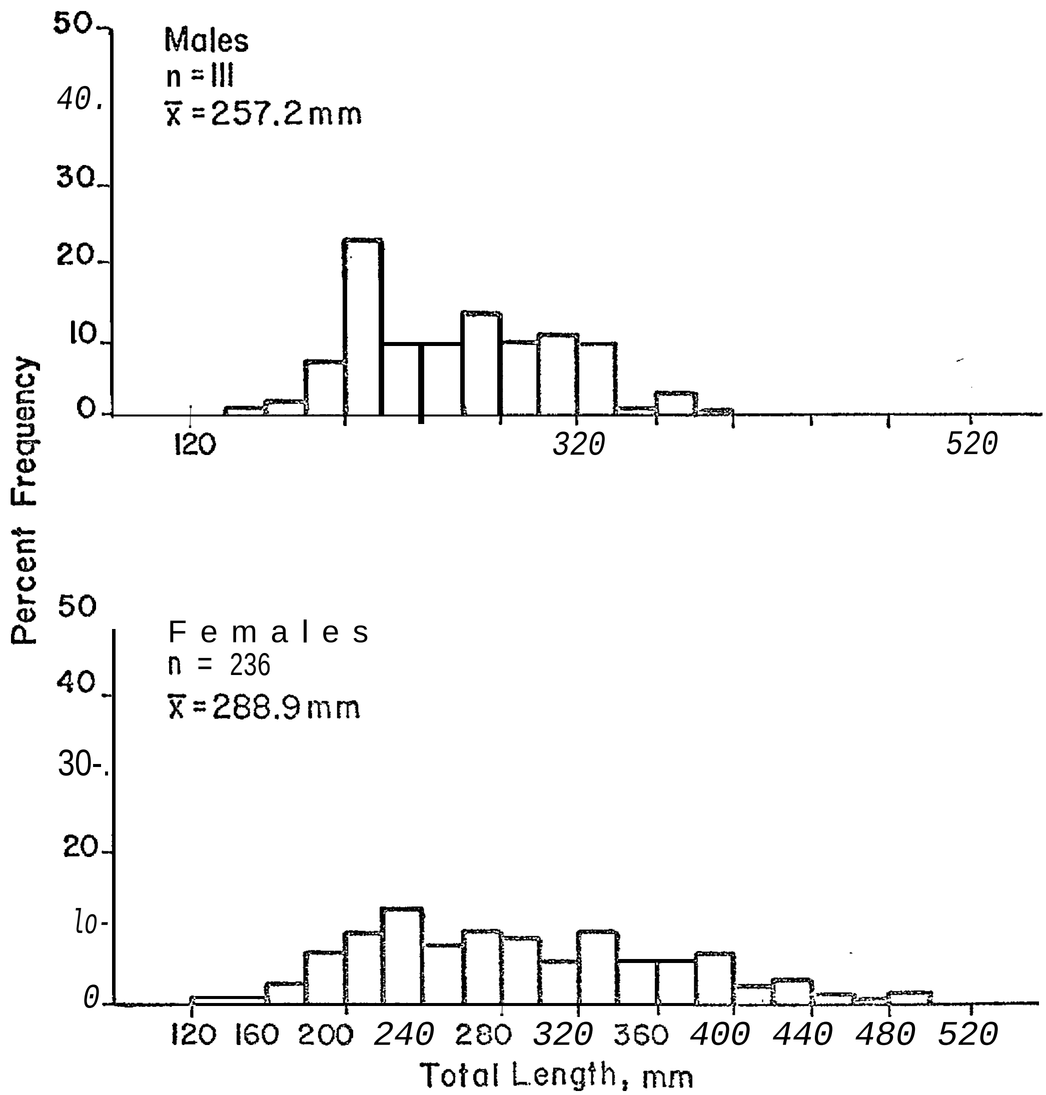
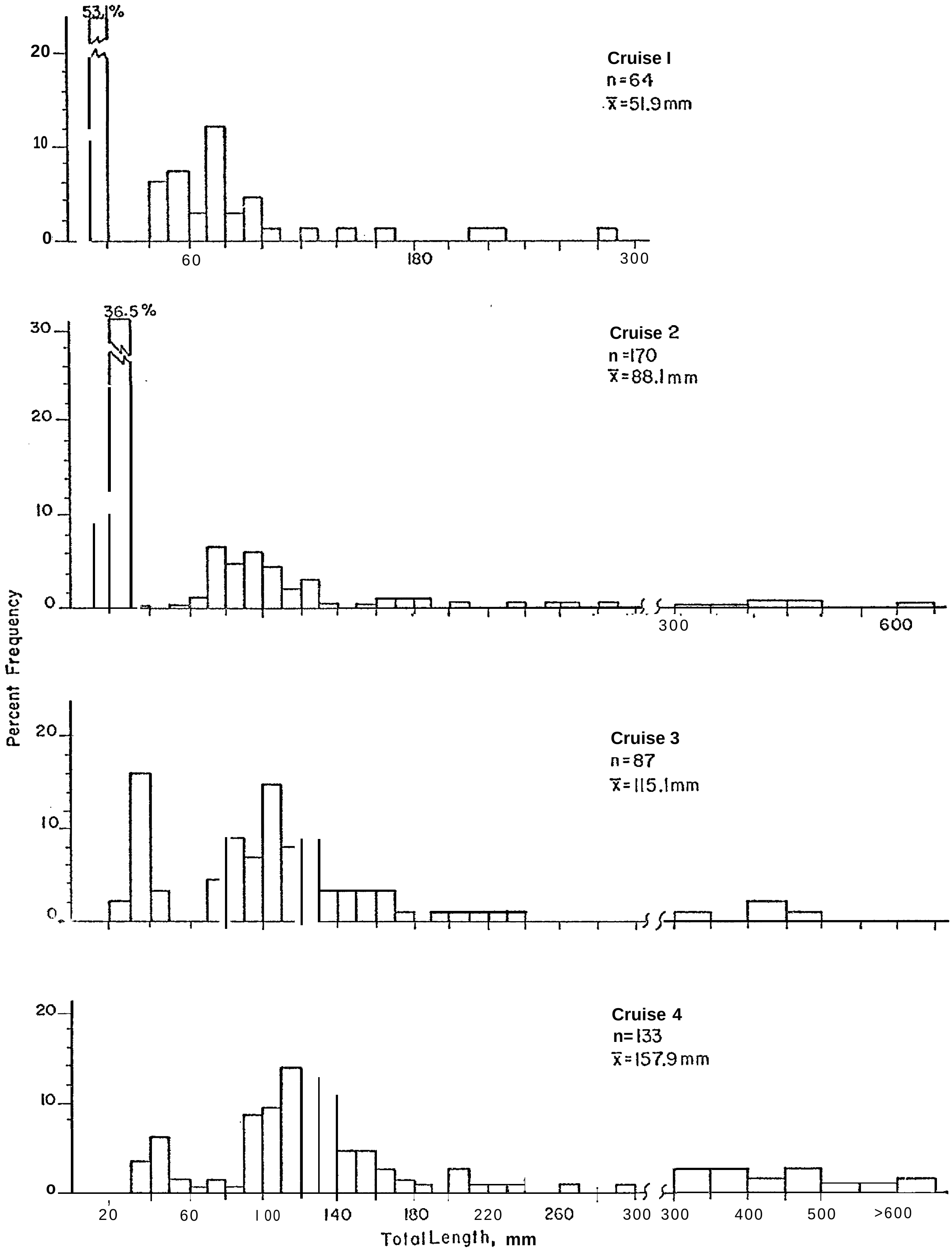


Fig. 44, Lengths of rock green ling, *Hexagrammos lagocephalus*, pooled over all bays and gear types.



Fig, 45. Lengths. of male and female rock. greenling, pooled over all bays, gear types, and cruises,



Fig, 46. Lengths of great sculpin, *Myoxocephalus polyacanthocep halus*, pooled over all bays and gear types,

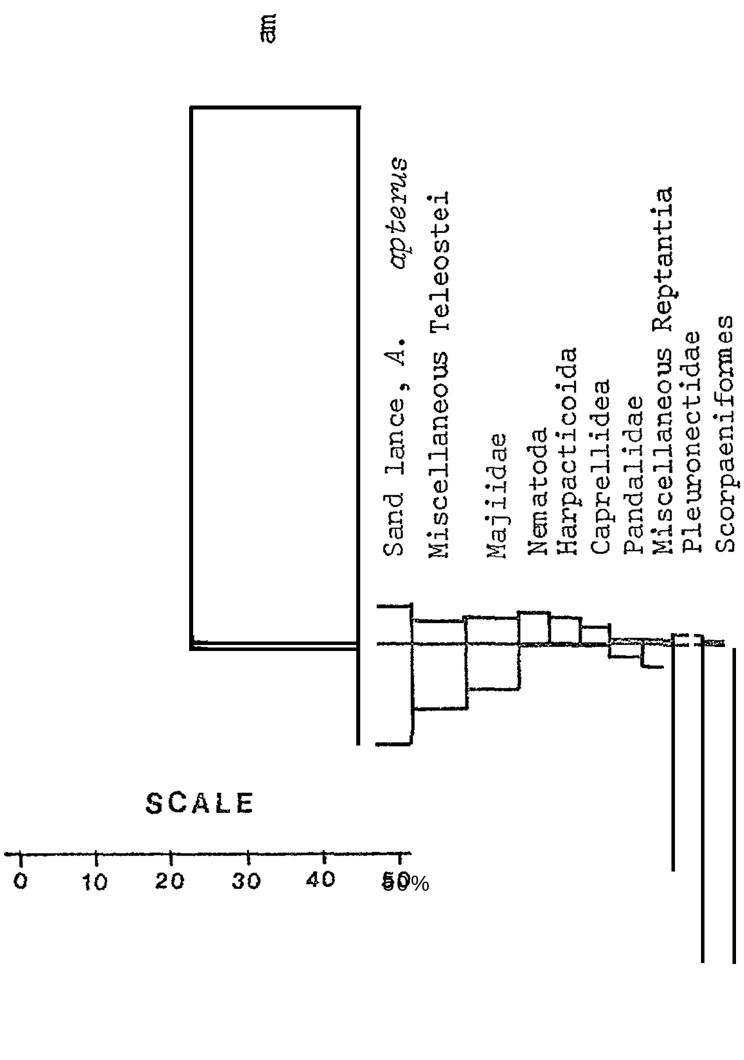


Fig. 47. Prey spectrum of 16 juvenile and 11 adult great sculpins, collected from all bays and cruises. There were no empty stomachs, and unidentified material comprised 10.1 percent of total weight of contents,

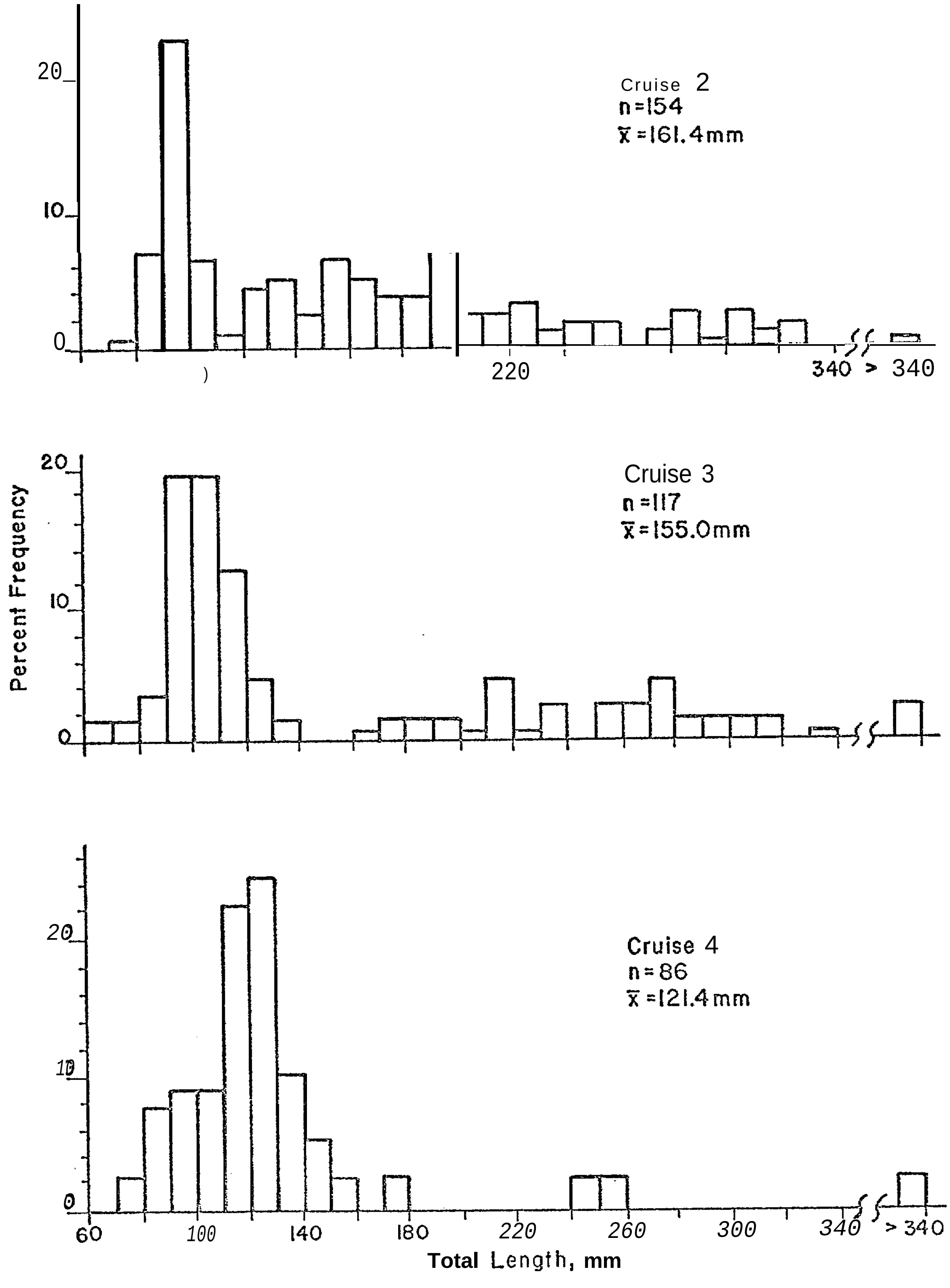


Fig. 48. Lengths of snake pricklebacks, *Lumpenus sagitta*, pooled over all bays and gear types.

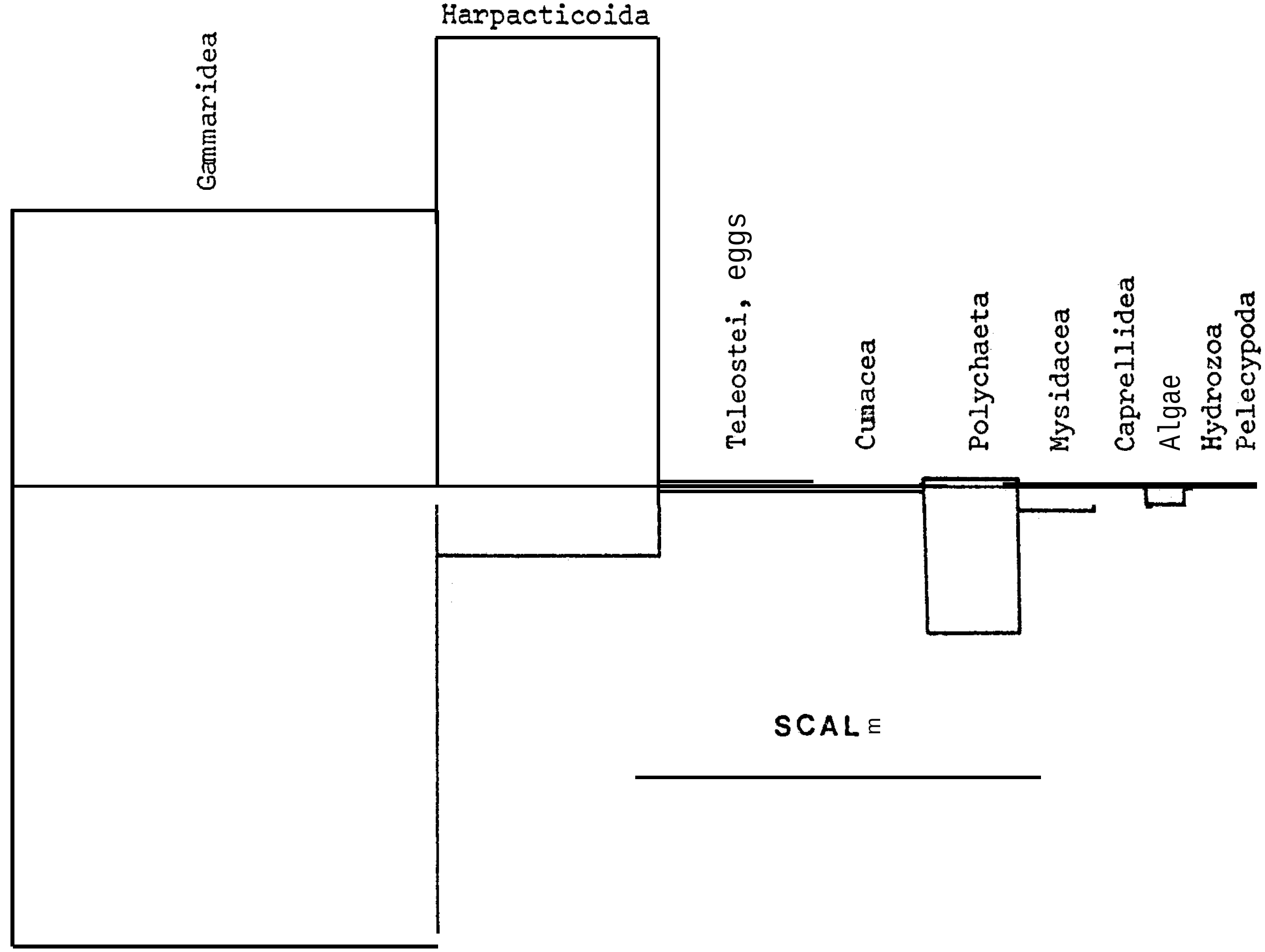


Fig. 49. Prey spectrum of 41 juvenile and adult snake pricklebacks collected mainly from Ugak Bay in late June and late July. There were no empty stomachs, and unidentified material comprised 45.6 percent of total weight of contents.

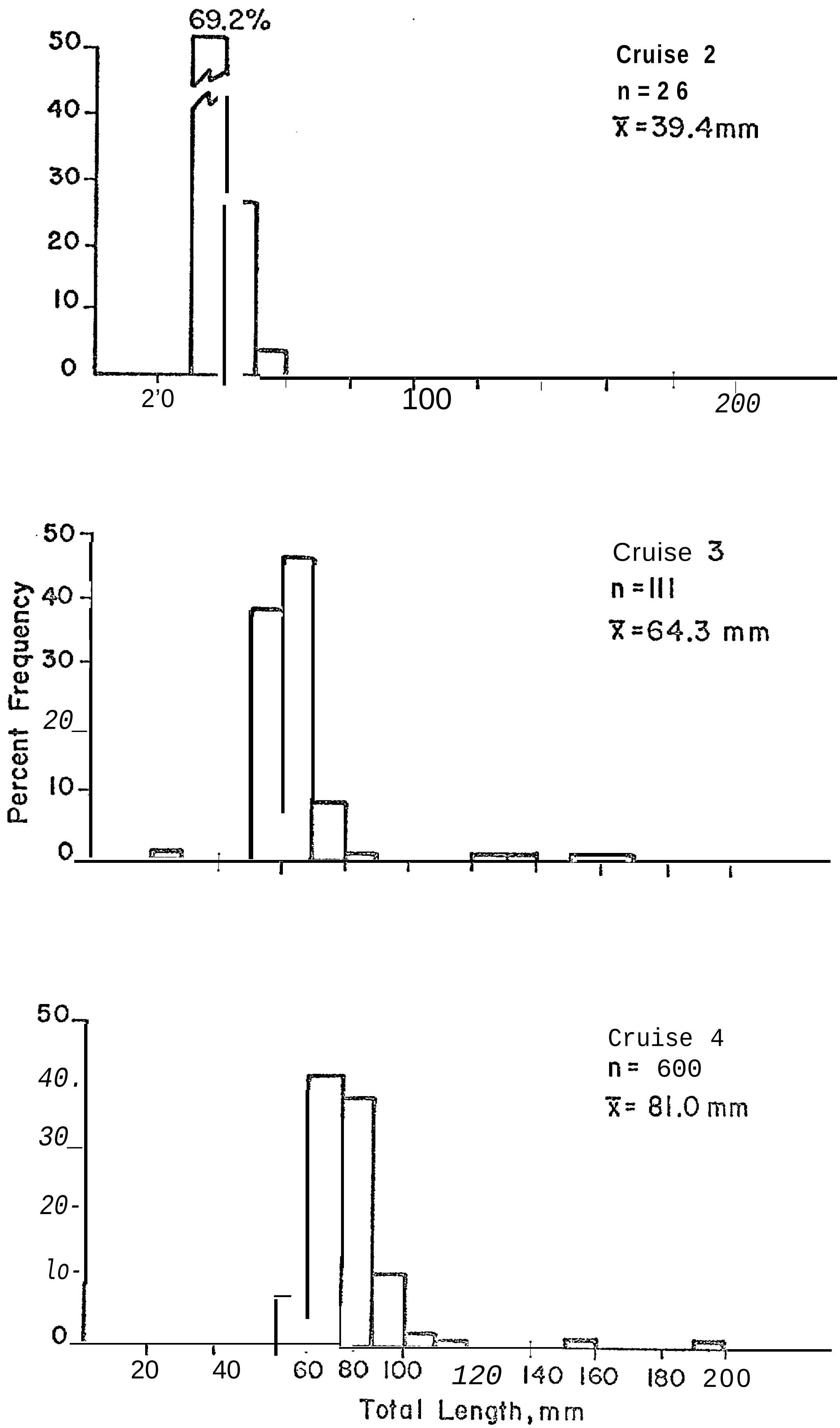


Fig. 50. Lengths of Pacific sand fish, *Trichodon trichodon*, pooled over all bays and gear types.

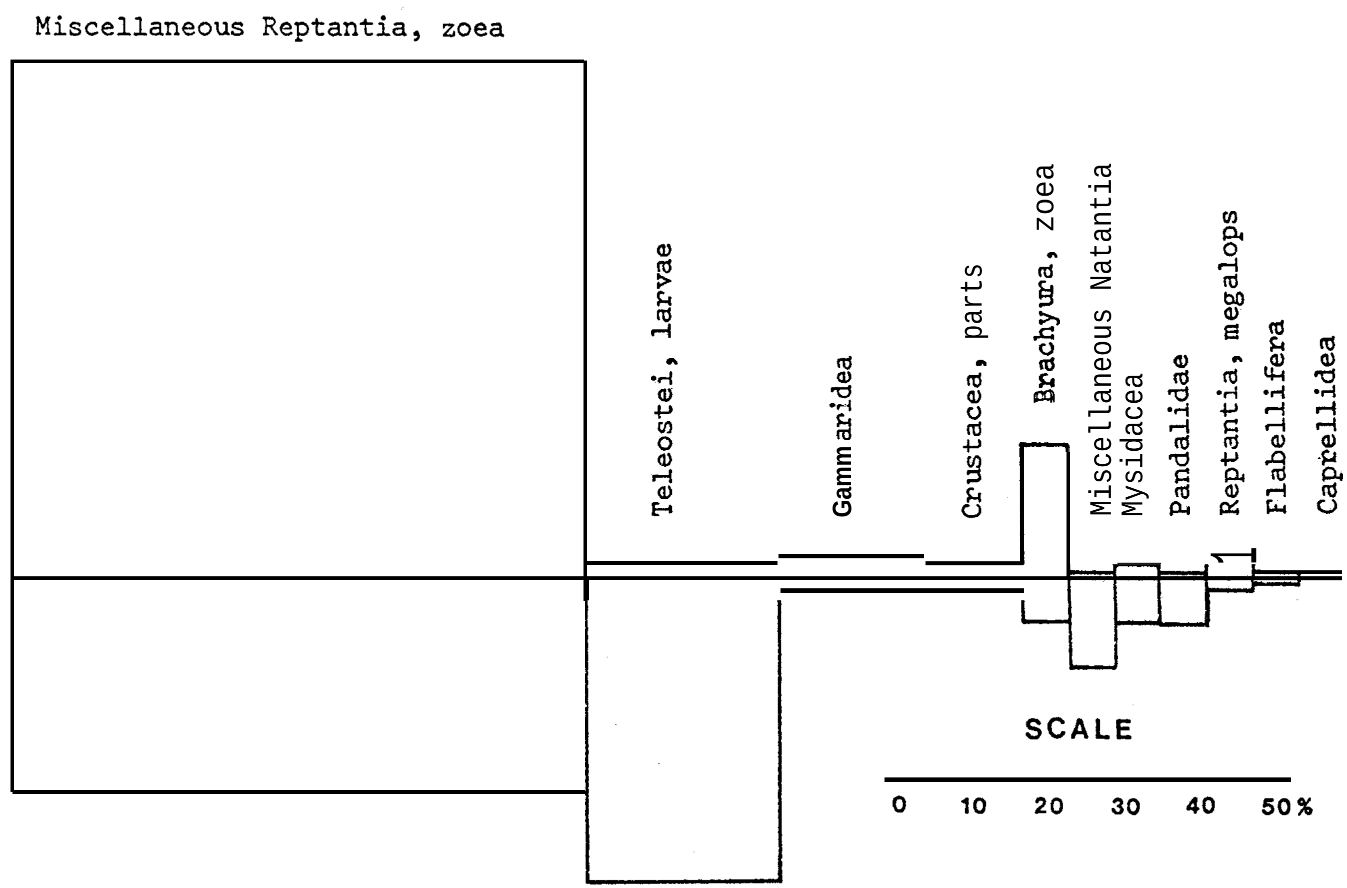


Fig. 51. Prey spectrum of 16 juvenile Pacific sandfish caught by midwater trawl in Ugak Bay in late August. There were no empty stomachs, and unidentified material comprised 36.9 percent of total weight of contents.

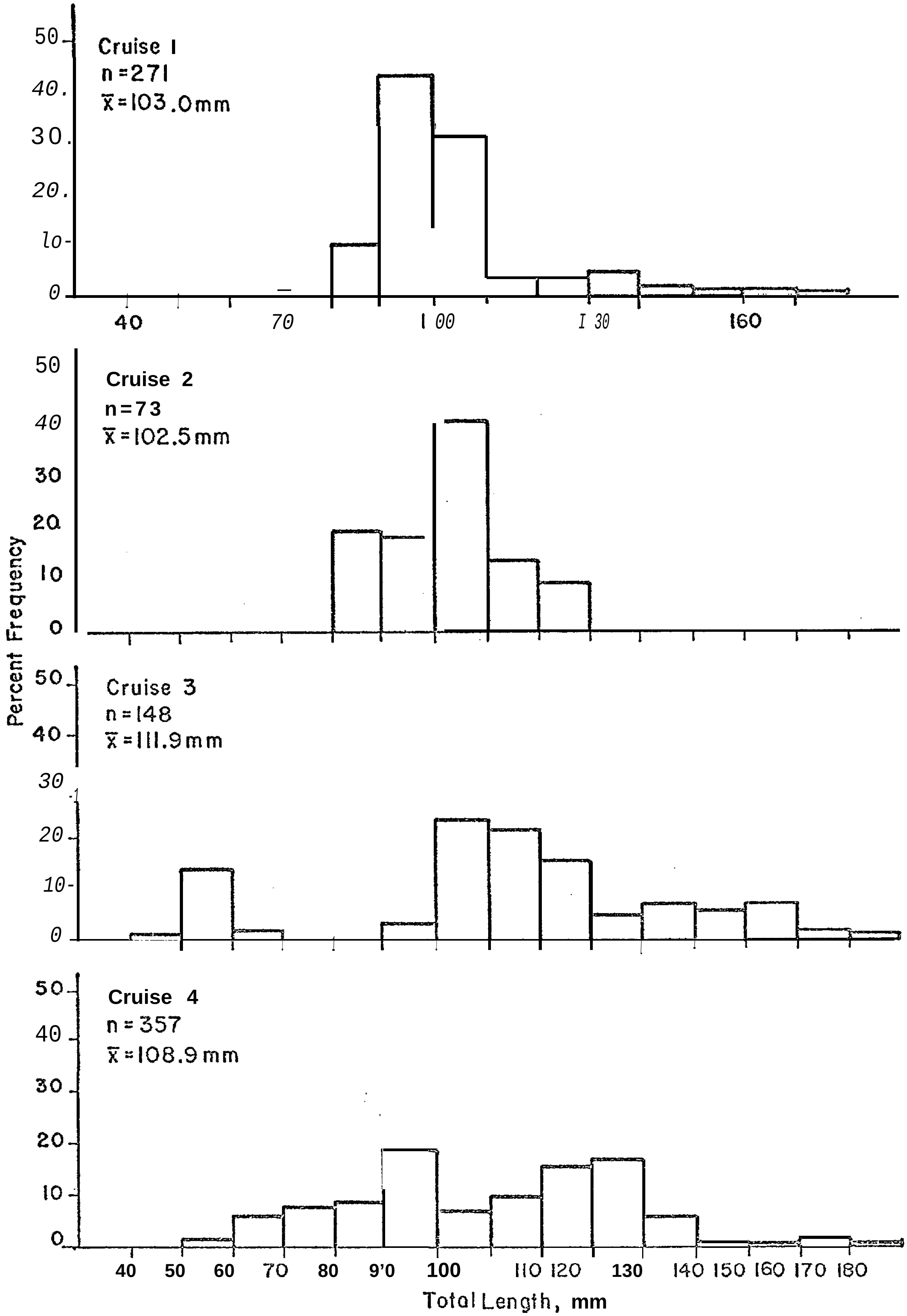


Fig. 52. Lengths of sand lance, *Ammodytes hexapterus*, pooled over all bays and gear types. No postlarvae were measured in the first two cruises.

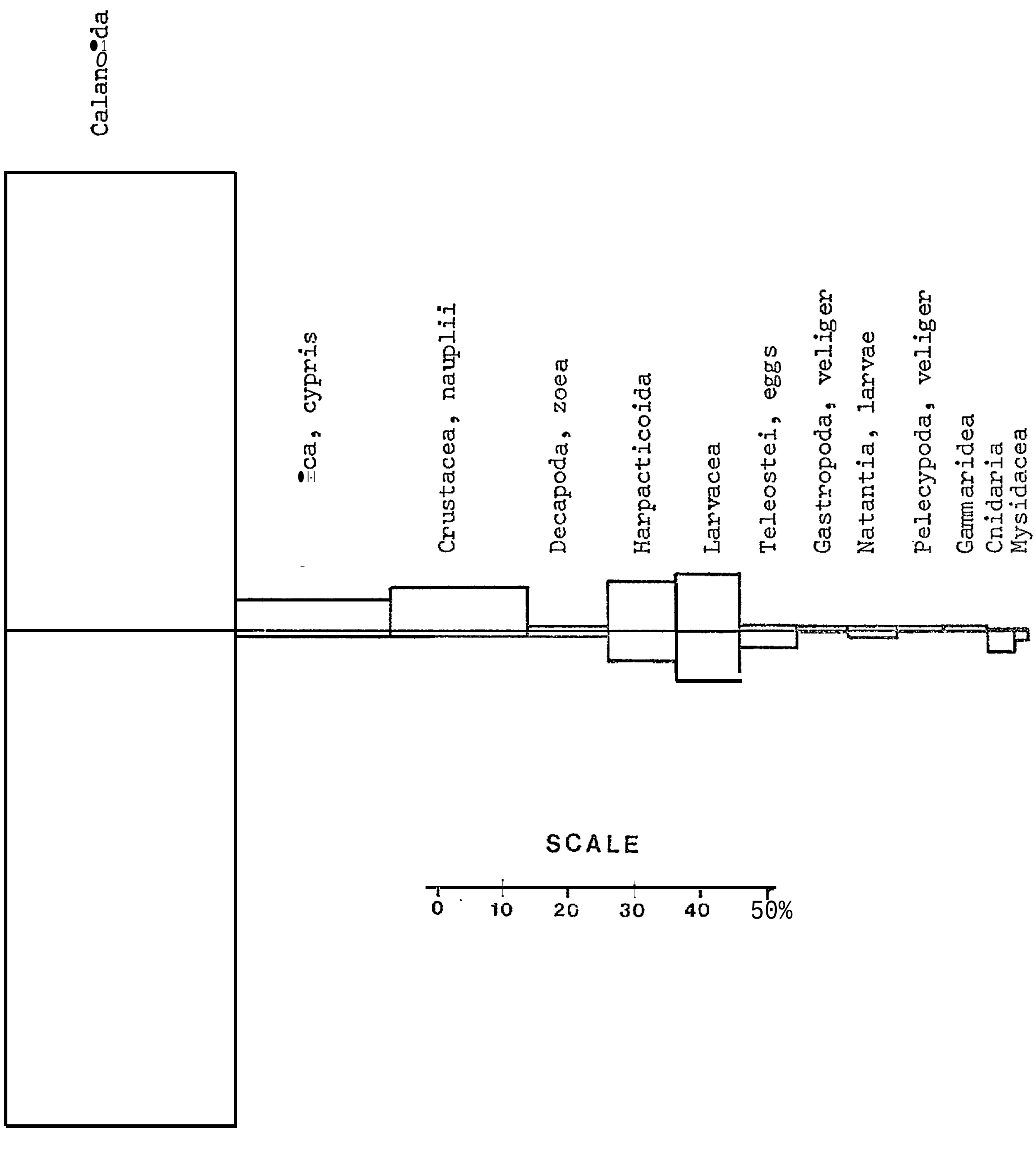


Fig. 53. Prey spectrum of 86 juvenile and adult sand lance caught in the intertidal zone of all bays, late June - mid-September. There were no empty stomachs, and unidentified material comprised 53.6 percent of total weight of contents.

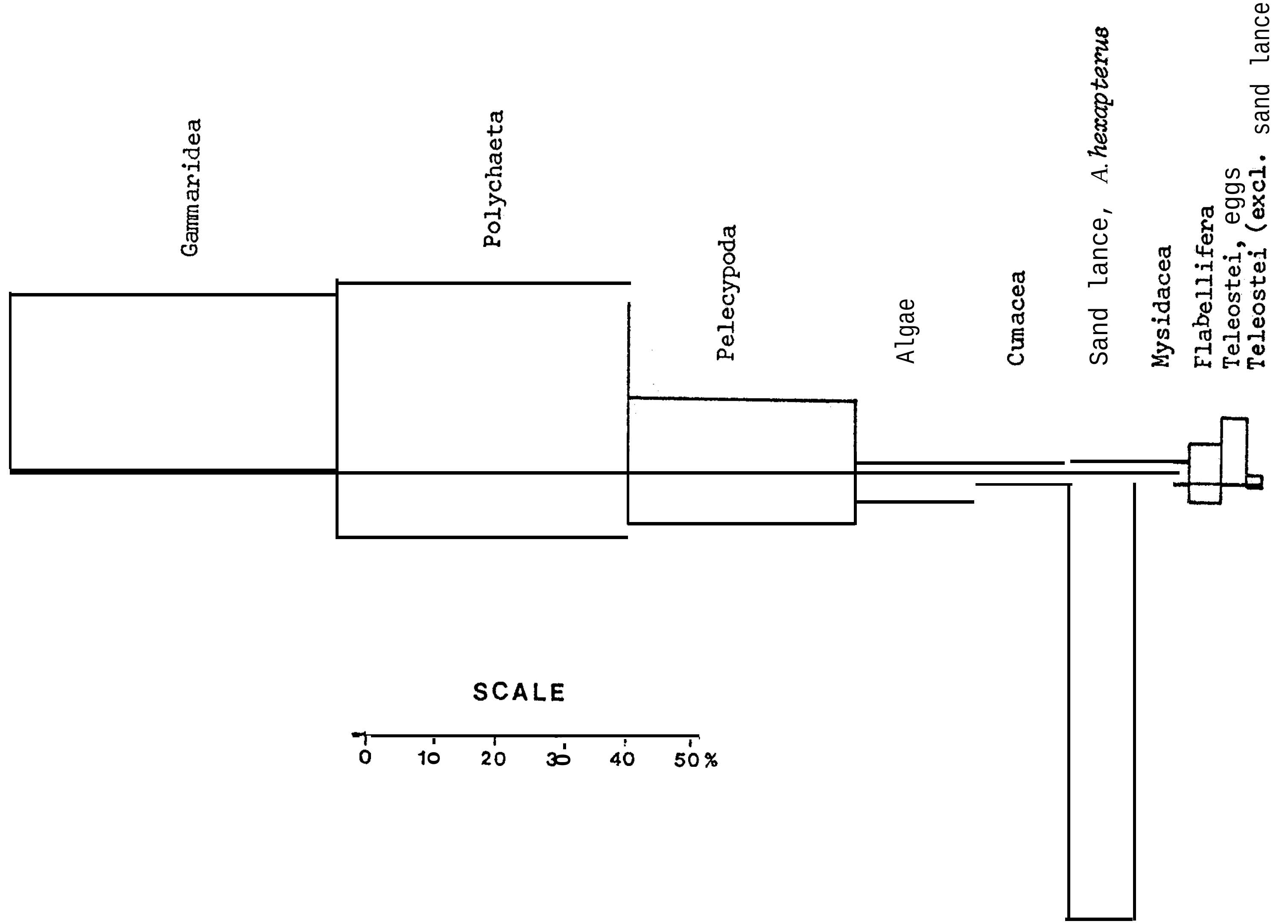


Fig. 55. Prey spectrum of 114 juvenile and adult rock sole caught mainly in Ugak Bay in late June to mid-September. There was 1 empty stomach, and unidentified material comprised 21.0 percent of total weight of contents.

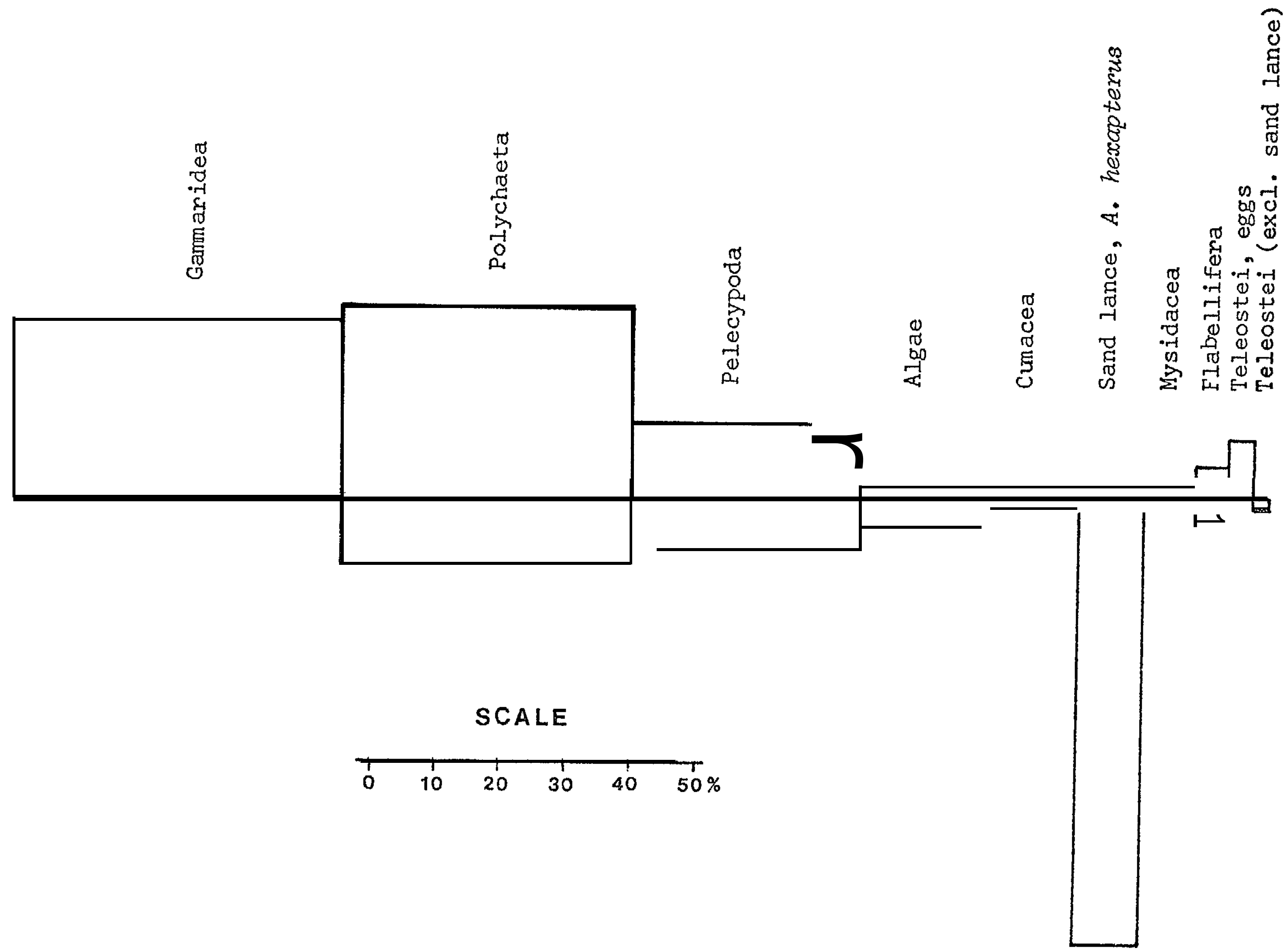


Fig. 55. Prey spectrum of 114 juvenile and adult rock sole caught mainly in Ugak Bay in late June to mid-September. There was 1 empty stomach, and unidentified material comprised 21.0 percent of total weight of contents.

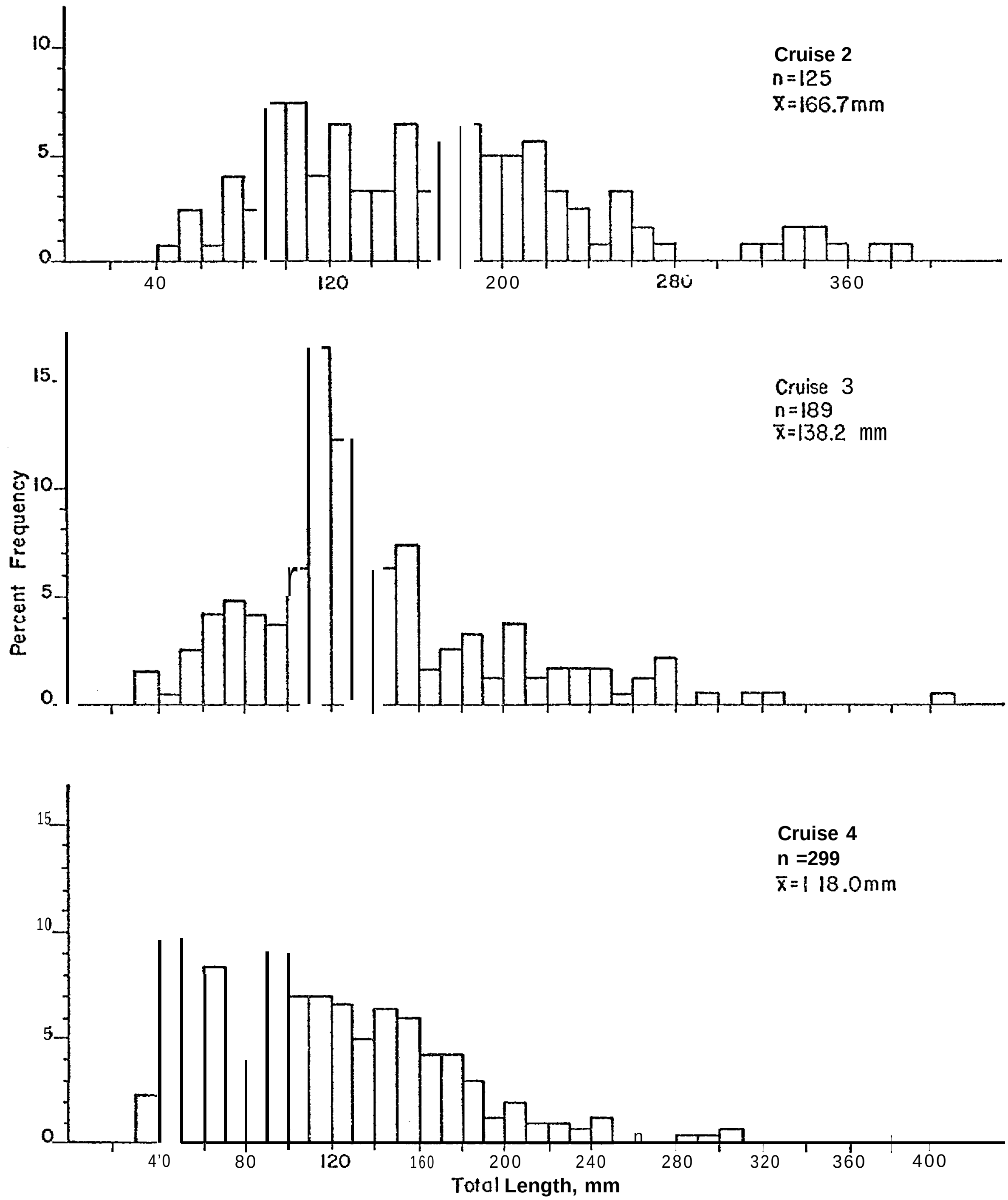


Fig. 56. Lengths of yellow fin sole, *Limanda aspera*, pooled over all bays and gear types.

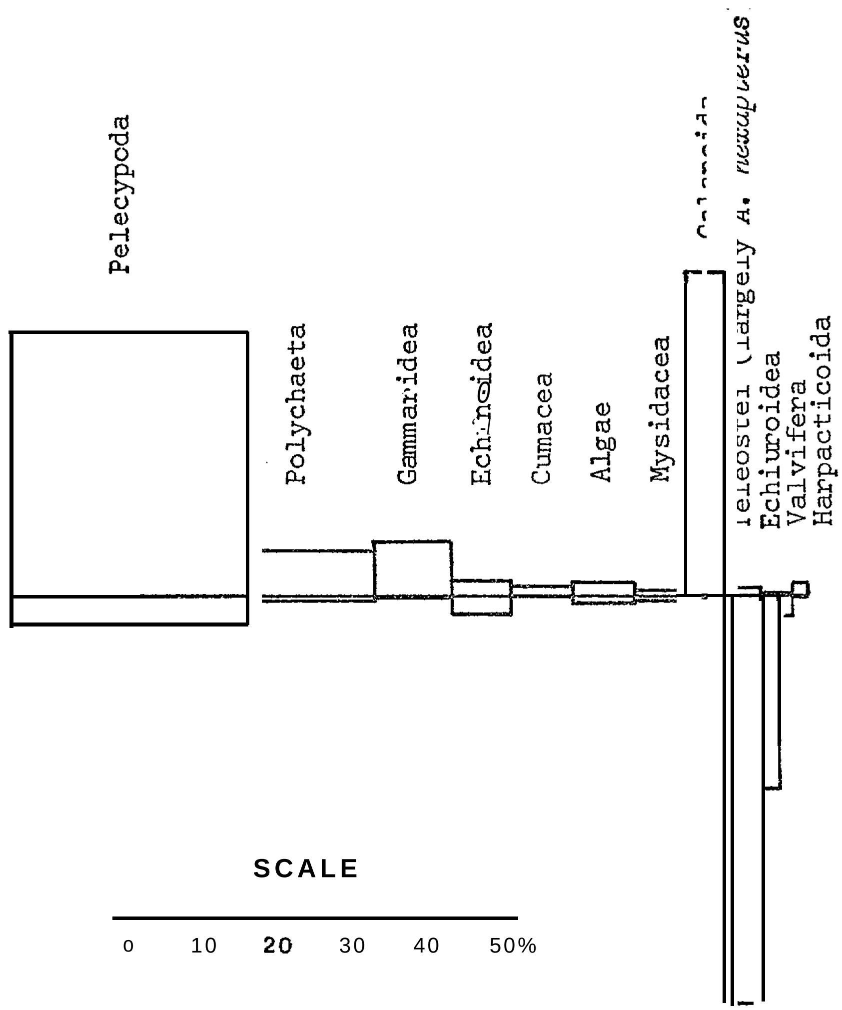


Fig. 57. Prey spectrum of 59 juvenile and adult yellow fin sole, *Limanda aspera*, caught in Ugak Bay from late June to early September. There were no empty stomachs, and unidentified material comprised 25.7 percent of total weight of contents.

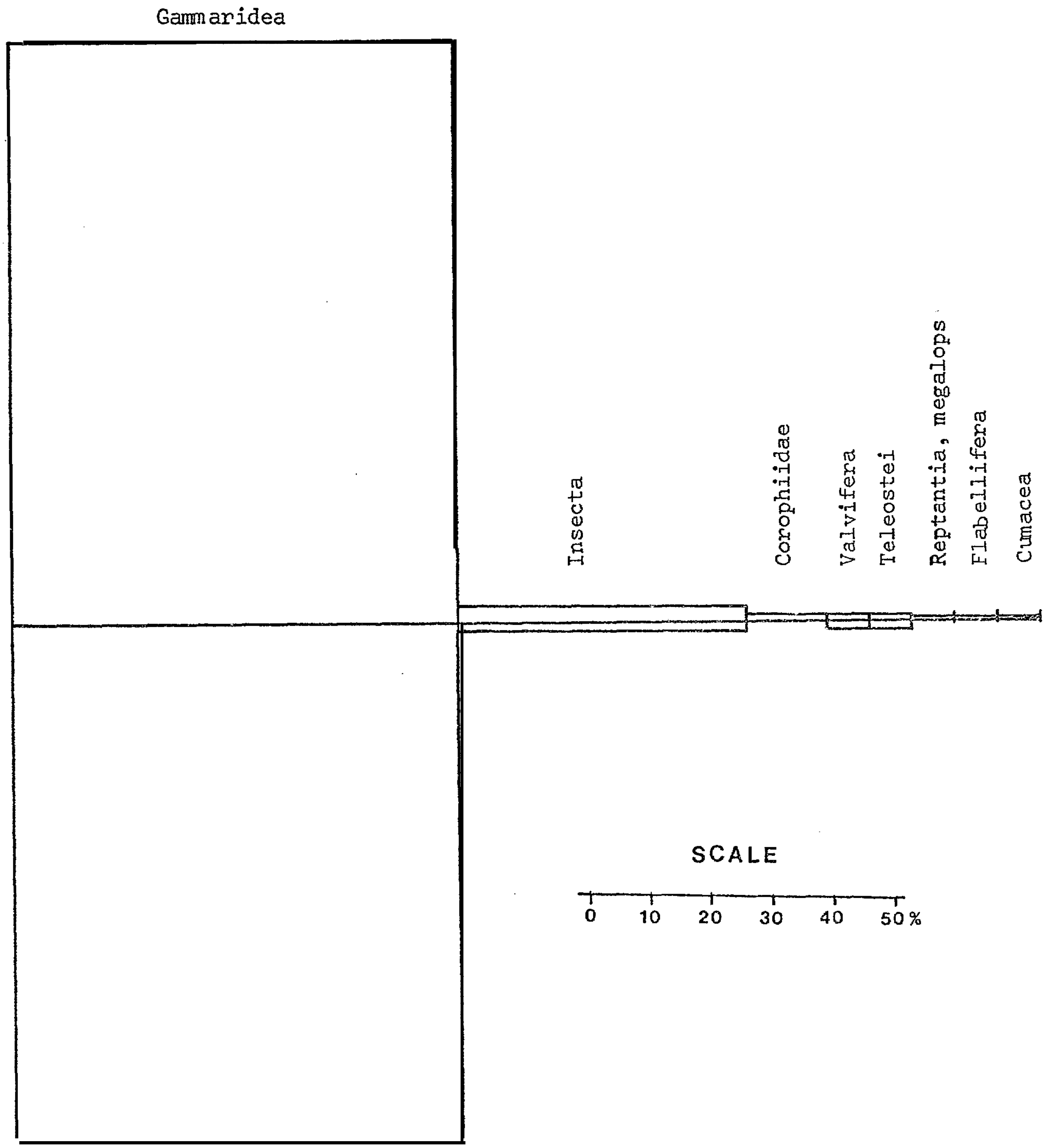


Fig. 58. Prey spectrum of 15 juvenile coho salmon, *Oncorhynchus kisutch*, caught in t-he intertidal zone of Alitak Bay in late June. There were no empty stomachs, and unidentified material comprised 24,8 percent of total weight of contents.

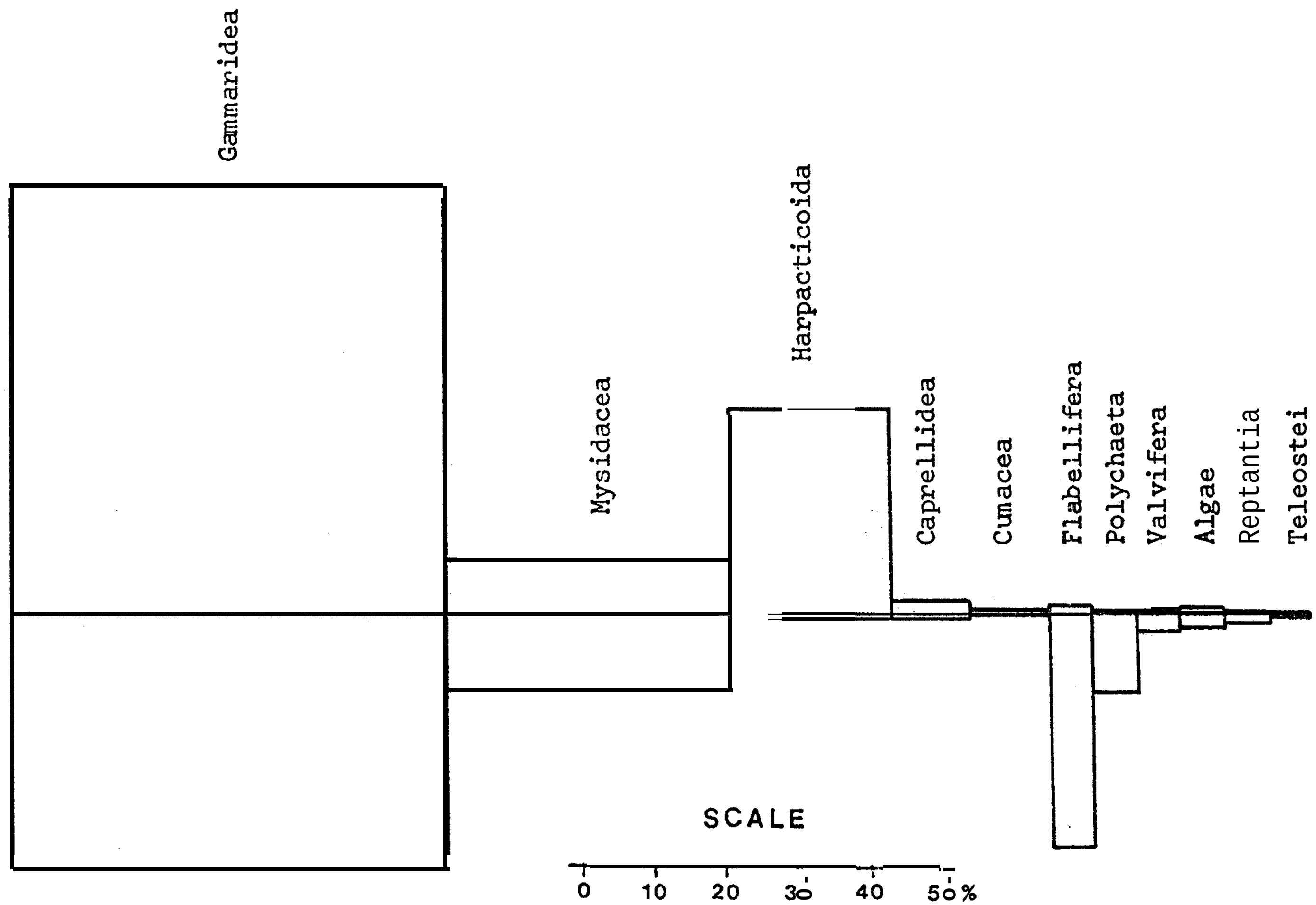


Fig. 59. Prey spectrum of 18 juvenile (Age 1+) Pacific cod, *Gadus macrocephalus*, caught in the nearshore zone of Alitak Bay in late May and June. There were no empty stomachs, and unidentified material comprised 56.9 percent of total weight of contents.

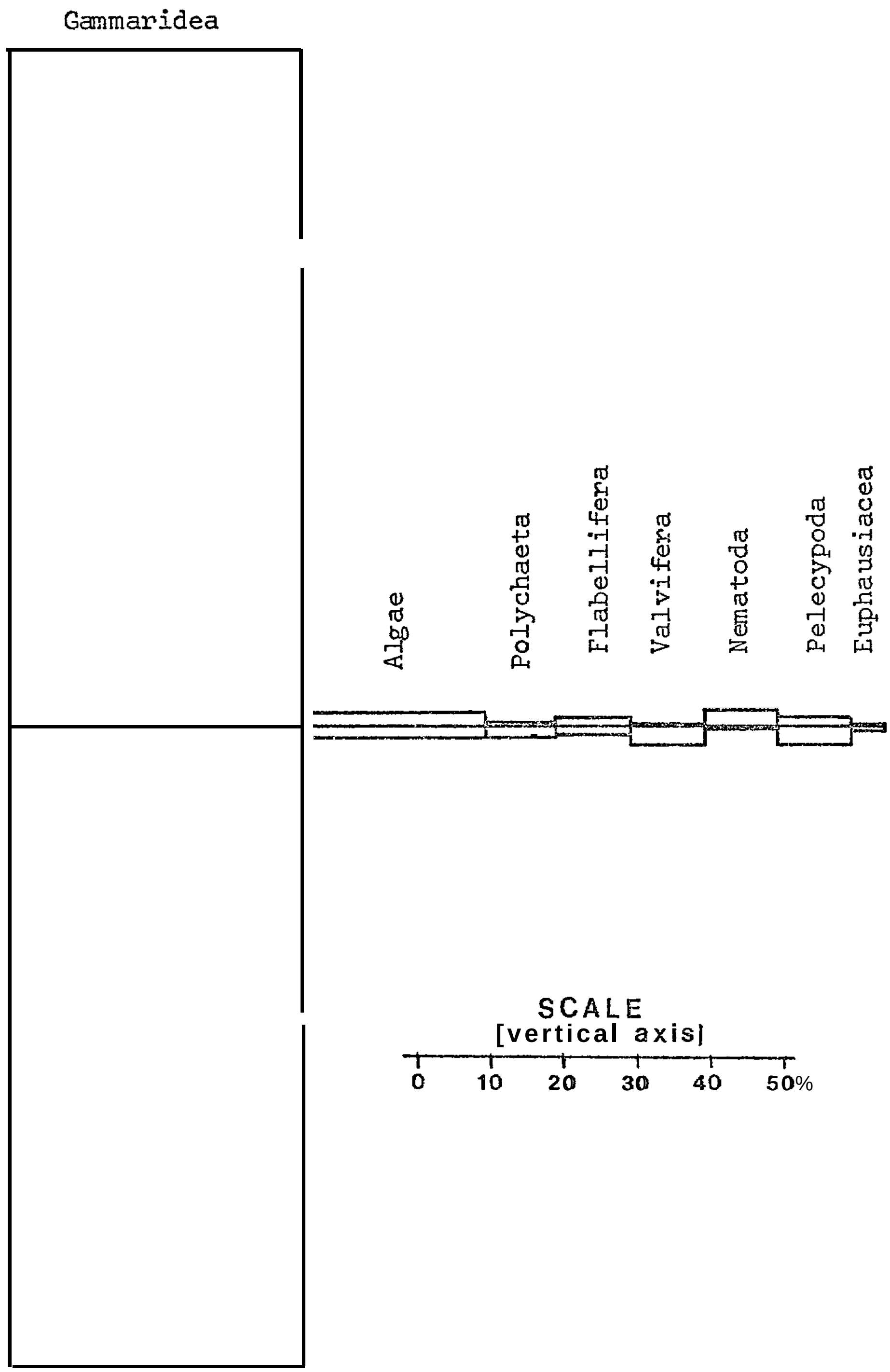


Fig. 60. Prey spectrum of 10 starry flounder, *Platichthys stellatus*. 1 mm = 2 percent for frequency of occurrence (horizontal axis). There were no empty stomachs, and unidentified material comprised 21.6 percent of total weight of contents.

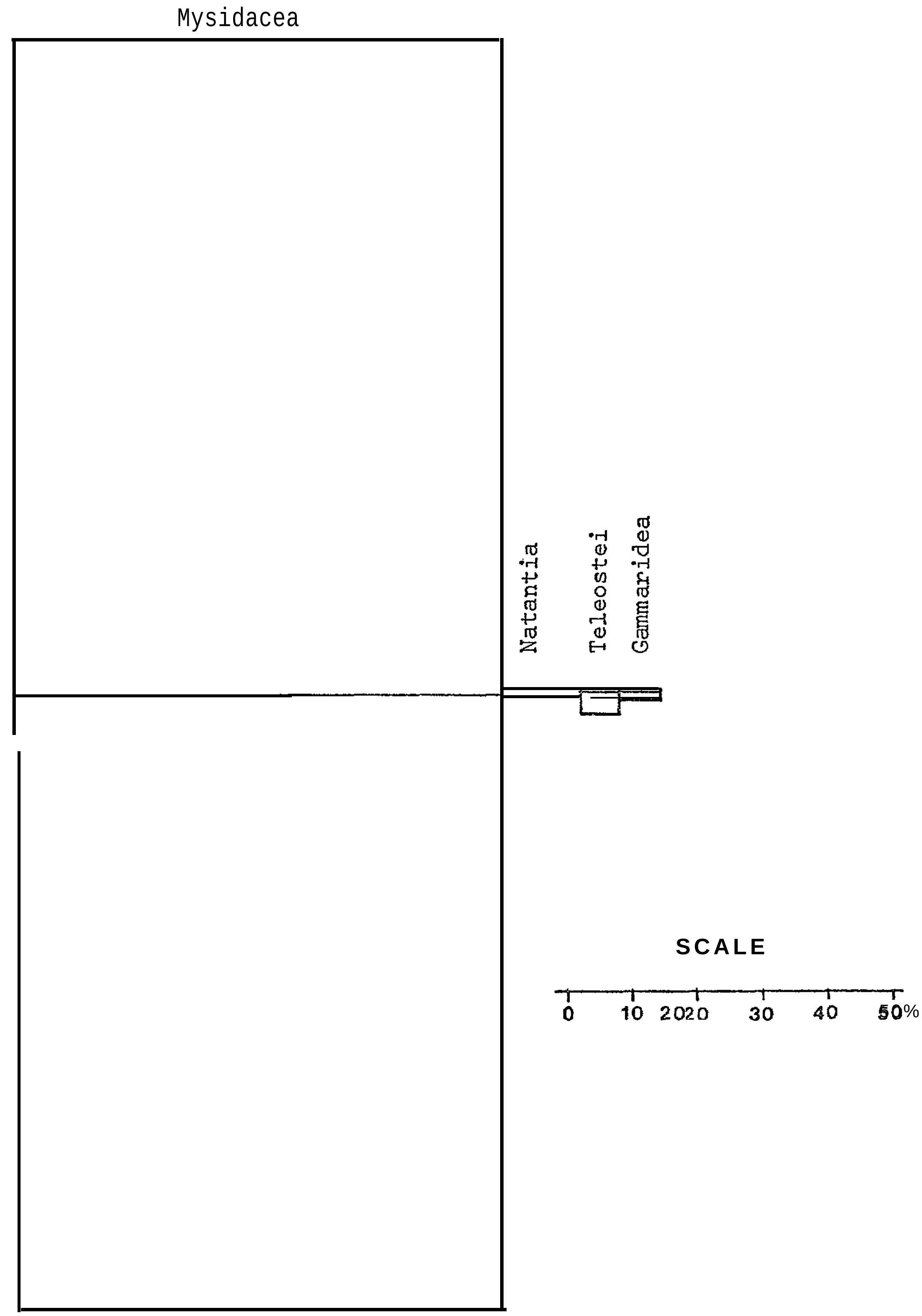


Fig. 61. Prey spectrum of 16 sand sole, *Psettichthys melanostictus*, caught in Ugak Bay from late June to early September. There were no empty stomachs, and unidentified material comprised 12.9 percent of total weight of contents.

APPENDICES

Appendix Table 1. Checklist of all species caught, their occurrence by cruise, bay, and gear type, and their relative abundance[1,2]

Species	Occurrence by cruise	Occurrence by bay	Occurrence by gear type	Relative abundance
Rajidae				
Big skate *Raja binoculata*	3	U	Try	R
Unidentified Osteichthyes	1	U,K	M,B	
Clupeidae				
Pacific herring *Clupea harengus pallasi*	1,2,3,4	U,K,A	T,M,B,Tr	A
Salmonidae				
Pink salmon *Oncorhynchus gorbuscha*	1,2,3,4	U,K,A	T,M,B	V
Chum salmon *Oncorhynchus keta*	1,2,3,4	U,K,A	T,M,B,Tr	A
Coho salmon *Oncorhynchus kisutch*	2,3,4	U,K,A	T,M,B	C
Sockeye salmon *Oncorhynchus nerka*	2,3,4	U,K,A	T,B,Tr	I
Dolly Varden *Salvelinus malma*	1,2,3,4	U,K,A	T,B,Tr	C
Osmeridae				
Surf smelt *Hypomesus pretiosus*	1,4	U	B	I
Capelin *Mallotus villosus*	1,2,3,4	U,K,A	T,M,B,Try	V
Gadidae				
Pacific cod *Gadus macrocephalus*	1,2,3,4	U,A	T,B,Try,Tr	I
Pacific tomcod *Microgadus proximus*	4	U	Try	R
Walleye pollock *Theragra chalcogramma*	1,2,3,4	U,K,A	T,M,B,Try	I

Appendix Table 1. Checklist of all species caught, their occurrence by cruise, bay, and gear type, and their relative abundance - Continued

Species	Occurrence by cruise	Occurrence by bay	Occurrence by gear type	Relative abundance
Zoarcidae				
Alaska eelpout *Bothrocara pusillum*	1,3,4	A	M	I
Gasterosteidae				
Threespine sticklebacks *Gasterosteus aculeatus*	1,3,4	U,K,A	T,M,B	C
Tube-snout *Aulorhynchus flavidus*	4	K	Try	R
Unidentified Scorpaeniformes	1,2	U,K	M,B,Try	
Scorpaenidae				
Black rockfish *Sebastes melanops*	2,3,4	U,K,A	T,B,Try,Tr	I
Tiger rockfish *Sebastes nigrocinctus*	4	A	T	R
Hexagrammidae				
Unidentified *Hexagrammos*	1,2,3	U,K,A	T,M,B	
Kelp greenling *Hexagrammos decagrammus*	4	U,K	Try, Tr	R
Rock greenling *Hexagrammos lagocephalus*	2,3,4	U,K,A	T,B,Try,Tr	A
Masked greenling *Hexagrammos octogrammus*	1,2,3,4	U,K,A	T,M,B,Try,Tr	A
Whitespotted greenling *Hexagrammos stelleri*	1,2,3,4	U,K,A	T,M,B,Try,Tr	A
Lingcod *Ophiodon elongatus*	4	A	T, Try	R
Atka mackerel *Pleurogrammus monopterygius*	4	A	Tr	R

Appendix Table 1. Checklist of all species caught, their occurrence by cruise, bay, and gear type, and their relative abundance - Continued

Species	occurrence by cruise	Occurrence by bay	Occurrence by gear type	Relative abundance
Cottidae				
Unidentified Cottidae	1,2,3,4	U,K	T,M,B,Try	
Padded sculpin *Artedius fenestralis*	3,4	U,A	B	I
Crested sculpin *Blepsias bilobus*	2,4	U,A	T,M,Try,Tr	R
Silverspotted sculpin *Blepsias cirrhosus*	1,2,3,4	U,K,A	T,M,B,Try	C
Buffalo sculpin *Enophrys bison*	2,3,4	U,K	B,Try	R
Antlered sculpin *Enophrys diceraus*	4	U,A	Try, Tr	R
Soft sculpin *Gilbertidia sigalutes*	3,4	U	T,M	R
Gymnocanthus spp. (*G. galeatus* and *G. pistilliger*)	2,3,4	U,K,A	B, Try	C
Red Irish Lord *Hemilepidotus hemilepidotus*	2,4	U,K,A	Try, Tr	R
Yellow Irish Lord *Hemilepidotus jordani*	1,2,3,4	U,K,A	T,M,B,Try,Tr	I
Pacific staghorn sculpin *Leptocottus armatus*	1,2,3,4	U,A	B,Try,Tr	I
Unidentified *Myoxocephalus*	1,3	U,K,A	M,B,Tr	
Plain sculpin *Myoxocephalus jaok*	2,3,4	U,K,A	T,B,Try,Tr	I
Great sculpin *Myoxocephalus polyacanthocephalus*	1,2,3,4	U,K,A	T,B,Try,Tr	A

Appendix Table 1. CheckList of all species caught, their occurrence by cruise, bay, and gear type, and their relative abundance - Continued

Species	Occurrence by cruise	Occurrence by bay	Occurrence by gear type	Relative abundance
Shorthorn sculpin *Myoxocephalus scorpius*	2,3,4	U,K,A	B,Try,Tr	I
Eyeshade sculpin *Nautichthys pribilovius*	3	A	Tr	R
Porocottus quadrifilis	2	u	B	R
Tadpole sculpin *Psychrolutes paradoxus*	3	K	T	R
Manacled sculpin *Synchirus gilli*	4	K	Try	R
Unidentified *Triglops*	1,2	U,K,A	M , Try	
Ribbed sculpin *Triglops pingeli*	3,4	U,A	M , Try	I
Bigmouth sculpin *Hemitripterus bolini*	3	K	M	R
Agonidae				
Aleutian alligator fish *Aspidophoroides bartoni*	4	u	Try	R
Bering poacher *Occella dodecaedron*	2,4	u	Try	R
Tubenose poacher *Pallasina barbata*	1,2,3,4	U,K,A	T,B,Try	C
Sturgeon poacher *Agonus acipenserinus*	2,3,4	U,K,A	T,M,B,Try,Tr	C
Cyclopteridae				
Unidentified Cyclopteridae	3	u	T	
Smooth lumpsucker *Aptocyclus ventricosus*	4	A	M	

Appendix Table 1. Checklist of all species caught, their occurrence by cruise, bay, and gear type, and their relative abundance- Continued

Species	Occurrence by cruise	Occurrence by bay	Occurrence by gear type	Relative abundance
Unidentified *Liparis*	1	u	B	
Ribbon snailfish *Liparis cyclopus*	3,4	U,A	Try	R
Trichodontidae				
Pacific sandfish *Trichodon trichodon*	1,2,3,4	U,K,A	T,M,B,Try	V
Bathymasteridae Unidentified Bathymasteridae	1,2	U,K,A	T,M,B	
Alaskan ronquil *Bathymaster caeruleofasciatus*	2,3,4	U,K	Try, Tr	R
Searcher *Bathymaster signatus*	3,4	u	Try	R
Anarhichadidae				
Bering wolffish *Anarhichas orientalism*	2,3	U,K	T,M	R
Stichaeidae				
Unidentified Stichaeidae	1,2	U,K,A	T,M,Try	
High cockscomb *Anoplarchus purpurescens*	1,4	U,K	B,Tr	R
Decorated warbonnet *Chirolophis polyactocephalus*	4	A	Tr	R
Unidentified *Lumpenus*	3,4	A	M	
Stout eelblenny *Lumpenus medius*	4	U,A	M,Tr	C
Snake prickleback *Lumpenus sagitta*	1,2,3,4	U,K,A	T,M,B,Try	A

Appendix Table 1. Checklist of all species caught, their occurrence by cruise, bay, and gear type, and their relative abundance - Continued

Species	Occurrence by cruise	Occurrence by bay	Occurrence by gear type	Relative abundance
Arctic shanny *Stichaeus punctatus*	2,4	K,A	Try	R
Pholidae				
Penpoint gunnel *Apodichthys flavidus*	3	K	Try	R
Crescent gunnel *Pholis laeta*	1,2,3,4	U,K,A	B, Try	C
Zaproridae				
Prowfish *Zaprora silenus*	3,4	K,A	T,M	R
Ammodytidae				
Pacific sand lance *Ammodytes hexapterus*	1,2,3,4	U,K,A	T,M,B,Try	V
Pleuronectidae				
Unidentified Pleuronectidae	4	A	Try	
Flathead sole *Hippoglossoides elassodon*	3,4	U,K	T,M,Try	I
Pacific halibut *Hippoglossus stenolepis*	2,3,4	U,K,A	Try , Tr	I
Butter sole *Isopsetta isolepis*	2,3,4	U,K	Try	I
Rock sole *Lepidopsetta bilineata*	1,2,3,4	U,K,A	T,M,B,Try,Tr	A
Yellowfin sole *Limanda aspera*	2,3,4	U,K,A	M,B,Try,Tr	A
Starry flounder *Platichthys stellatus*	1,2,3,4	U,K,A	B,Try,Tr	C
Alaska plaice *Pleuronectes quadrituberculatus*	2,3	u	Try	R

Appendix Table 1. Checklist of all species caught, their occurrence by cruise, bay, and gear type, and their relative abundance - Continued

Species	Occurrence by cruise	Occurrence by bay	Occurrence by gear type	Relative abundance
Pleuronectidae (Continued)				
Sand sole *Psettichthys melanostictus*	1,2,3,4	U,K,A	B , Try	I

[1]Nomenclature is standardized according to Bailey, Reeve, M. , et al. (1970).

[2]Symbols:
Cruise; cruise number
Bay; U = Ugak Bay, K = Kaiugnak Bay, A=Alitak Bay.
Gear type; T = *tow* net, M = midwater trawl, B = beach seine, Try = try net, Tr = trammel net.
Relative abundance categories were arbitrarily defined on the basis of total catch in numbers over the entire study: R = rare (1-10), I = infrequent (11-100), C = common (101-500), A = abundant (501-15000), V = very abundant (> 15001).

Appendix Table 2. Cumulative tow net catches of all species from three regions of Ugak Bay, Cruise 2

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L=larvae, J=juveniles, A=adults).

Species	Life history stages	Inner (7 hauls) No.	Inner (7 hauls) CPUE	Middle (7 hauls) No.	Middle (7 hauls) CPUE	Outer (6 hauls) No.	Outer (6 hauls) CPUE	Total (20 hauls) No.	Total (20 hauls) CPUE
M. villosus	J,A			2291	327.29	2	.33	2293	114.65
O. *keta*	J			119	17.00	13	2.17	132	6.60
O. gorbuscha	J	1	.14	28	4.00			29	1.45
O. *kisutch*	post-smelt			4	.57	21	3.50	25	1.25
O. *nerka*	post-smelt	9	1.29			3	.50	12	.60
S. *malma*	A			5	.71	1	.17	6	.30
T. *trichodon*	J			5	.71			5	.25
Hexagrammos spp.	J	1	.14					1	.05
H. jordani	A					1	.17	1	.05
A. orientalism	J			1	.14			1	.05
Unidentified Stichaeidae	J					1	.17	1	.05

Appendix Table 3. Cumulative tow net catches of all species from three regions of Ugak Bay, Cruise 3

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L=larvae, J=juveniles, A=adults).

Species	Life history stages	Inner (7 hauls) No.	Inner (7 hauls) CPUE	Middle (7 hauls) No.	Middle (7 hauls) CPUE	Outer (6 hauls) No.	Outer (6 hauls) CPUE	Total (20 hauls) No.	Total (20 hauls) CPUE
M. villosus	J,A	7308	1044.00	4492	641.71	29	4.83	11829	591.45
T. trichodon	J	2	.29	453	64.71	1937	322.83	2392	119.60
O. gorbuscha	J	93	13.29	153	21.86	13	2.17	259	12.95
L. sagitta	J	5	.71	31	4.43			36	1.80
O. kisutch	post-smolt	22	3.14	11	1.57			33	1.65
O. nerka	post-smelt			17	2.43	1	.17	18	.90
O. keta	J	6	.86	7	1.00	3	.50	16	.80
S. malma	A			4	.57			4	.20
G. aculeatus	J	4	.57					4	.20
Hexagrammos spp.	J	1	.14			2	.33	3	.15
T. chalcogramma	J			1	.14	1	.17	2	.10
A. hexapterus	L,J	1	.14	1	.14			2	.10
B. cirrhosus	J	1	.14					1	.05
G. sigalutes	J			1	.14			1	.05
H. jordani	A			1	.14			1	.05
Unidentified Cyclopteridae	J			1	.14			1	.05

Appendix Table 4. Cumulative tow net catches of all species from three regions of Ugak Bay, Cruise 4

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L=larvae, J=juveniles, A=adults).

Species	Life history stages	Inner (7 hauls) No.	Inner (7 hauls) CPUE	Middle (7 hauls) No.	Middle (7 hauls) CPUE	Outer (6 hauls) No.	Outer (6 hauls) CPUE	Total (20 hauls) No.	Total (20 hauls) CPUE
T. trichodon	J	1009	144.14	393	56.14	1271	211.83	2673	133.65
M. villosus	L,J	875	125.00	50	7.14	192	32.00	1117	55.85
O. gorbuscha	J	5	.71	44	6.29	65	10.83	114	5.70
S. melanops	J			5	.71	5	.83	10	.50
O. keta	J	1	.14	5	.71			6	.30
O. nerka	post-smelt	2	.29	3	.43	1	.17	6	.30
G. aculeatus	J	3	.43	2	.29			5	.25
O. kisutch	post-smelt			4	.57			4	.20
L. sagitta	J			2	.29	2	.33	4	.20
A. hexapterus	J	3	.43					3	.15
T. chalcogramma	J	1	.14					1	.05
Hexagrammos spp.	J	1	.14					1	.05
B. bilobus	J	1	.14					1	.05
H. jordani	J					1	.17	1	.05
P. barbata	J			1	.14			1	.05
A. acipenserinus	J					1	.17	1	.05

Appendix Table 5. Cumulative surface trawl catches of all species from three regions of Ugak Bay, Cruise 1

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L=larvae, J=juveniles, A=adults).

Species	Life history stages	Inner (7 hauls) No.	Inner (7 hauls) CPUE	Middle (6 hauls) No.	Middle (6 hauls) CPUE	Outer (3 hauls) No.	Outer (3 hauls) CPUE	Total (16 hauls) No.	Total (16 hauls) CPUE
A. hexapterus	L,J,A	1431	204.43	932	155.33	5	1.67	2368	148.00
M. villosus	L,J,A	92	13.14					92	5.75
O. gorbuscha	J			6	1.00	1	.33	7	.44
Unid. Stichaeidae	L	6	.86	1	.17			7	.44
C. h.. *pallasi*	J	6	.86					6	.38
Unid. Scorpaeniformes	L	4	.57	1	.17			5	.31
H. jordani	J	5	.71					5	.31
B. cirrhosus	J	1	.14	1	.17	1	.33	3	.19
G. *aculeatus*	A	1	.14					1	.06
Triglops sp.	L					1	.33	1	.06
T. *trichodon*	L					1	.33	1	.06
Unidentified Bathymasteridae	L			1	.17			1	.06

Appendix Table 6. Cumulative midwater trawl catches of all species from three regions of Ugak Bay, Cruise 1

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L=larvae, J=juveniles, A=adults).

Species	Life history stages	Inner (4.5 hauls)		Middle (2 hauls)		Outer (3 hauls)		Total (9.5 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE	No.	CPUE
A. hexapterus	A	152	33.78	37	18.50	16	5.33	205	21.58
M. villosus	L,A	178	39.56	6	3.00			184	19.37
Triglops sp.	L,J	2	.44	3	1.50	8	2,67	13	1.37
H. jordani	J	5	1.11			6	2.00	11	1.16
Unid. Scorpaeniformes	L,J	3	.67					3	.32
Unid. Bathymasteridae	L	1	.22	1	.50			2	.21
Unid. Osteichthyes	L			1	.50			1	.11
C. h. pallasi	J	1	.22					1	.11
O. gorbuscha	J	1	.22					1	.11
H. octogrammus	J	1	.22					1	.11
B. cirrhosus	J			1	.50			1	.11

Appendix Table 7. Cumulative midwater trawl catches of all species from three regions of Ugak Bay, Cruise 3

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L=larvae, J=juveniles, A=adults).

Species	Life history stages	Inner (9 hauls) No.	Inner (9 hauls) CPUE	Middle (8 hauls) No.	Middle (8 hauls) CPUE	Outer (6 hauls) No.	Outer (6 hauls) CPUE	Total (23 hauls) No.	Total (23 hauls) CPUE
M. villosus	J,A	988	109.78	2528	316.00	90	15.00	3606	156.78
T. trichodon	J,A	1	.11	546	68.25	285	47.50	832	36.17
L. sagitta	L,J,A	31	3.44	53	6.63			84	3.65
A. hexapterus	L,J	34	3.78					34	1.48
H. elassodon	J	16	1.78					16	.70
H. jordani	L,J	9	1.00	1	.13			10	.43
O. gorbuscha	J	6	.67					6	.26
G. sigalutes	J.	3	.33	1	.13			4	.17
T. chalcogramma	J			2	.25	1	.17	3	.13
O. kisutch	post-smelt					2	.33	2	.09
L. bilineata	A	1	.11	1	.13			2	.03
C. h.. pallasi	A	1	.11					1	.04
O. keta	J	1	.11					1	.04
B. cirrhosus	J			1	.13			1	.04
T. pingeli	A			1	.13			1	.04
A. acipenserinus	J			1	.13			1	.04

Appendix Table 8. Cumulative midwater trawl catches of all species from three regions of Ugak Bay, Cruise 4

CPUE values are mean catches per unit of effort, cumulative catch/ number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L . larvae, J = juveniles, A . adults)

Species	Life history stages	Inner (7 hauls) No.	Inner (7 hauls) CPUE	Middle (6 hauls) No.	Middle (6 hauls) CPUE	Outer (6 hauls) No.	Outer (6 hauls) CPUE	Total (19 hauls) To	Total (19 hauls) CPUE
T. trichodon	J	980	140.00	597	99.50	11558	1926.33	13135	691.32
M. villosus	J	455	65.00	4670	778.33	177	29.50	5302	279.05
L. sagitta	A	4	.57					4	.21
T. chalcogramma	J	2	.29					2	.11
B. bilobus	A	2	.29					2	.11
G. sigalutes	J	2	.29					2	.11

Appendix Table 9. Cumulative beach seine catches of all species from three regions of Ugak Bay, Cruise 1

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Inner (5 hauls)		Middle (6 hauls)		Outer (5 hauls		Total (16 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE	No.	CPUE
A. hexapterus	A	4	.80	7310	1218.33			7314	457.13
O. gorbuscha	J	205	41.00	53	8.83	195	39.00	453	28.31
M. polyacanthocephalus	J	113	22.60			4	.80	117	7.31
O. keta	J	65	13.00	17	2.83			82	5.13
S. malma	A	44	8.80	1	.17	14	2.80	59	3,69
M. villosus	A			36	6.00			36	2.25
Myoxocephalus sp. (probably *M. polyacanthocephalus*)	J	16	3.20			4	.80	20	1.25
H. pretiosus	A					17,	3.40	17	1.06
Unidentified Scorpaeniformes	L,J	17	3.40					17	1.06
P. stellatus	A,J	1	.20	2	.33	7	1.40	10	.63
B. cirrhosus	J,A	7	1.40					7	.44
H. octogrammus	A	4	.80					4	.25
P. laeta		3	.60					3	.19
L. armatus	J,A	1	.20	1	.17			2	.13
Unidentified Bathymasteridae	J					2	.40	2	.13
G. aculeatus	A			1	.17			1	.06
P. barbata	A			1	.17			1	.06
Liparis sp.	J		.20					1	.06
L. bilineata	A			1	.17			1	.06
P. melanostictus	A			1	.17			1	.06

Appendix Table 10. Cumulative beach seine catches of all species from three regions of Ugak Bay, Cruise 2

CPUE values are mean catches per unit of effort, cumulative catch/ number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Inner (7 hauls)		Middle (3 hauls)		Outer (4 hauls)		Total (14 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE	No.	CPUE
A. hexapterus	A	2107	301.00	93	31.00	2	.50	2202	157.29
O. gorbuscha	J	17	2.43	2099	699.67	2	.50	2118	151.29
O. keta	J	71	10.14	38	12.67	15	3.75	124	8.86
M. polyacanthocephalus	J,A	93	13.29	12	4.00	15	3.75	120	8.57
P. stellatus	A	3	.43	2	.67	14	3.50	19	1.36
L. bilineata	J,A	1	.14	6	2.00	11	2.75	18	1.29
L. sagitta	A					12	3.00	12	.86
O. kisutch	J					8	2.00	8	.57
H. jordani	J	6	.86					6	.43
H. octogrammus	J,A	5	.71					5	.36
B. cirrhosus	J	5	.71					5	,36
S. malma	A					4	1,00	4	.29
L. armatus	A,J	1	.14			3	.75	4	.29
P. barbata	J	3	.43	1	.33			4	,29
E. bison	J			2	.67	1	.25	3	.21
P. laeta		3	.43					3	,21
P. melanostictus	A			1	.33	2	.50	3	.21
S. melanops	J	2	.29					2	.14
P. quadrifilis		2	.29					2	,14
O. nerka	Post-smelt	1	.14					1	.07
M. villosus	A,			1	.33			1	.07
Unidentified Scorpaeniformes	L	1	.14					1	.07
H. lagocephalus	J	1	.14					1	.07
Unidentified Cottidae		1	.14					1	.07
Gymnocanthus sp.	J	1	.14					1	.07

Appendix Table 11, Cumulative beach seine catches of all species from three regions of Ugak Bay, Cruise 3

CPUE values are mean catches per unit of effort, cumulative catch/ number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Inner (8 hauls) No.	Inner (8 hauls) CPUE	Middle (3 hauls) No.	Middle (3 hauls) CPUE	Outer (3 hauls) No.	Outer (3 hauls) CPUE	Total (14 hauls) No.	Total (14 hauls) CPUE
O. gorbuscha	J,A	23	2.88	10378	3459.33	13	4.33	10414	743.86
O. keta	J,A	51	6.38	672	224.00	13	4.33	736	52.57
A. hexapterus				463	154.33			463	33.07
L. sagitta	A			309	103.00	43	14.33	352	25.14
M. villosus	J					300	100*OO	300	21.43
M. polyacanthocephalus	J	52	6.50	10	3.33	3	1.00	65	4.64
L. bilineata	J	5	.63	7	2.33	26	8.67	38	2.71
H. stelleri	J	19	2.38	6	2.00	9	3.00	34	2.43
P. laeta	A	28	3.50					28	2.00
S. malma	A	3	.38	4	1.33	15	5.00	22	1.57
H. octogrammus	J	21	2.63					21	1.50
B. cirrhosus	J.	11	1.38					11	.79
P. melanostictus						9	3.00	9	.64
P. barbata	J	3	.38	5	1.67			8	.57
L. armatus	A	1	.13	3	1.00	3	1.00	7	.50
P. stellatus	J	5	.63					5	.36
G. aculeatus	J,A	4	.50					4	.29
O. nerka	post-smolt	2	.25					2	.14
E. bison	J					2	.67	2	.14
O. kisutch	J					1	.33	1	.07
A. fenestralis	A	1	.13					1	.07
Myoxocephalus sp.	J	1	.13					1	.07
A. acipenserinus	A					1	.33	1	.07

Appendix Table 12. Cumulative beach seine catches of all species from three regions of Ugak Bay, Cruise 4

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Inner (7 hauls) No.	Inner (7 hauls) CPUE	Middle (2 hauls) No.	Middle (2 hauls) CPUE	Outer (4 hauls) No.	Outer (4 hauls) CPUE	Total (13 hauls) No.	Total (13 hauls) CPUE
C. h. pallasi	L	1200	171.43					1200	92.31
A. hexapterus	A,J			649	324.50	480	120.00	1129	86.85
M. villosus	L	200	28.57					200	15.38
H. pretiosus	J					55	13.75	55	4.23
L. bilineata	J,A	3	.43	11	5.50	31	7.75	45	3.46
P. barbata	J,A	35	5.00	8	4.00	1	.25	44	3.38
T. trichodon	J			1	.50	41	10.25	42	3.23
H. octogrammus		29	4.14					29	2.23
M. polyacanthocephalus	J,A	11	1.57	12	6.00	4	1.00	27	2.08
B. cirrhosus	J	10	1.43	12	6.00	1	.25	23	1.77
H. lagocephalus	J	8	1.14	10	5.00	2	.50	20	1.54
P. stellatus	A	1	.14			12	3.00	13	1.00
S. malma	A	7	1.00			5	1.25	12	.92
Gymnocanthus spp.	J	4	.57	8	4.00			12	.92
H. stelleri	J	6	.86	5	2.50			11	.85
P. laeta	A	10	1.43					10	.77
O. keta	J	6	.86					6	.46
G. macrocephalus	J					5	1.25	5	.38
G. aculeatus	J	3	.43					3	,23
S. melanops	J	1	.14			2	.50	3	.23
A. fenestralis	J	3	.43					3	.23
L. armatus	A,J	2	.29			1	.25	3	.23
P. melanostictus	A					2	.50	2	,15
O. kisutch	J	1	.14					1	.08
H. jordani	J	1	.14					1	.08
M. scorpius	J	1	.14					1	.08

Appendix Table 13. Cumulative try net catches of all species from three regions of Ugak Bay, Cruise 2

CPUE values are mean catches per unit of effort, cumulative catch/ number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Inner (4 hauls)		Middle (17 hauls)		Outer (10 hauls)		Total (26 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE	No.	CPUE
L. sagitta	A,J			69	5.75	324	32.40	393	15.12
L. bilineata	J,A	26	6.50	18	1.50	129	12.90	173	6.65
L. aspera	J,A	10	2.50	91	7.58	14	1.40	115	4.42
I. isolepis	A					45	4.50	45	1.73
P. melanostictus	A			1	.08	17	1.70	18	.69
Gymnocanthus spp.	J,A	2	.50	4	.33	5	.50	11	.42
H. octogrammus	A	2	.50	7	.58			9	.35
P. barbata	A			3	.25	6	.60	9	.35
M. polyacanthocephalus	A,J	3	.75	3	.25	2	.20	8	.31
A. acipenserinus	A,J					6	.60	6	.23
P. stellatus	A					3	.30	3	.12
Unidentified Cottidae	J			2	.17			2	.08
H. jordani	J			2	.17			2	.08
L. armatus	A					2	.20	2	.08
Triglops sp. (probably *T. pingeli*)				2	.17			2	.08
H. stenolepis	A					2	.20	2	.08
R. binoculata	A					1	.10	1	.04
M. villosus	A					1	.10	1	.04
M. jaok	A	1	.25					1	.04
O. dodecaedron						1	.10	1	.04
P. quadrituberculatus	A			1	.08			1	.04

Appendix Table 14. Cumulative try net catches of all species, from three regions of Ugak Bay, cruise 3

CPUE values are mean catches per unit of effort, cumulative catch/ number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Inner (6 hauls) No.	Inner CPUE	Middle (7 hauls) No.	Middle CPUE	Outer (2 hauls) No.	Outer CPUE	Total (15 hauls) No.	Total CPUE
L. aspera	J,A	242	40.33	141	20.14	1	.50	384	25.60
L. bilineata	J,A	6	1.00	96	13.71	66	33.00	168	11.20
L. sagitta	A,J	1	,17	105	15.00	3	1.50	109	7.27
Gymnocanthus spp.	A	53	8.83	4	.57			57	3.80
T. pinge li	A			32	4.57			32	2.13
P, melanostictus	J					13	6.50	13	.87
H. elassodon		13	2.17					13	.87
M. jaok	J,A	12	2.00					12	.80
H. octogrammus	A,J	9	1.33	2	.29	1	.50	12	.80
M. polyacanthocephalus	A,J	7	1.17	1	.14	3	1.50	11	.73
P. lae ta	A	10	1.67					10	.67
P. stellatus	A					8	4.00	8	.53
H. stelleri	A	2	.33	2	.29	1	.50	5	.33
L. armatus	A					5	2.50	5	.33
T. chalcogramma	J			4	.57			4	.27
B. cirrhosus	J,A			4	.57			4	.27
P. barbata	A	1	.17	2	.29			3	.20
A. acipenserinus	A			1	.14	2	1.00	3	.20
H. lagocephalus	J,A			1	.14	1	.50	2	.13
H. jordani	A			2	.29			2	.13
M. scorpius	A	2	.33					2	.13
G. macrocephalus	J	1	.17					1	.07
B. caeruleofasciatus	A	1	.17					1	.07
B. signatus	J			1	.14			1	,07
H. stenolepis	J			1	.14			1	.07
P. quadritubercu latus	J			1	.14			1	.07

Appendix Table 15. Cumulative try net catches of all species from three regions of Ugak Bay, Cruise 4

CPUE values are mean catches per unit of effort, cumulative catch/ number GE hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Inner (3 hauls) No.	Inner (3 hauls) CPUE	Middle (9 hauls) No.	Middle (9 hauls) CPUE	Outer (8 hauls) No.	Outer (8 hauls) CPUE	Total (20 hauls) No.	Total (20 hauls) CPUE
L. aspera	J,A	207	69.00	170	18.89	5	.63	382	19.10
L. bilineata	J,A	11	3.67	112	12.44	118	14.75	241	12.05
Gymnocanthus spp.	A	77	25.67	13	1.44			90	4.50
L. sagitta	J,A	1	.33	5	.56	75	9.38	81	4.05
?. barbata	J			14	1.56	28	3.50	42	2.10
A. acipenserinus	A,J			14	1.56	20	2.50	34	1.70
H. stelleri	J,A	8	2.67	16	1.78	5	.63	29	1.45
B. cirrhosus	J,A			20	2.22	5	.63	.25	1.25
T. trichodon	J			2	.22	19	2.38	21	1.05
P. melanostictus	A,J			12	1.33	7	.88	19	.95
H. octogrammus	J,A	4	1.33	14	1.56			18	.90
P. stellatus	A			11	1.22	6	.75	17	.85
L. armatus	A	5	1.67	7	.78	1	.13	13	.65
M. jaok	J,A	10	3.33	2	.22			12	.60
H. jordani	J,A	7	2.33	2	.22			9	.45
H. elassodon	J,A	7	2.33	1	.11			8	.40
H. lagocephalus	J,A			5	.56			5	.25
P. laeta	A,J	1	.33	1	.11	2	.25	4	.20
S. melanops	J	2	.67	1	.11			3	.15
M. scorpius	A	2	.67	1	.11			3	.15
G. dodecaedron	A					3	.38	3	.15
H. stenolepis	J			3	.33			3	.15
I. isolepis	A			1	.11	2	.25	3	.15
M. proximus	A					2	.25	2	.10
T. chalcogramma	J			1	.11	1	.13	2	.10
L. cyclopus	J					2	.25	2	.10
B. signatus	J			1	.11	1	.13	2	.10
G. macrocephalus	A			1	.11			1	.05
E. bison	J			1	.11			1	.05
M. polyacanthocephalus	J					1	.13	1	.05
X. pingeli	J			1	.11			1	.05
A. bartoni	J	1	.33					1	.05
B. caeruleofasciatus	J	1	.33					1	.05
A. purpurescens	A	1	.33					1	.05
L. medius	A	1	.33					1	.05

Appendix Table 16. Cumulative trammel net catches of all species from three regions of Ugak Bay, Cruise 2

CPUE values are mean catches per unit of effort, cumulative catch/ number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Inner (4 hauls) No.	Inner (4 hauls) CPUE	Middle (2 hauls) No.	Middle (2 hauls) CPUE	Outer (2 hauls) No.	Outer (2 hauls) CPUE	Total (8 hauls) No.	Total (8 hauls) CPUE
H. octogrammus	A	105	26.25	29	14.50	9	4.50	143	17.88
H. lagocephalus	A	38	9.50	23	11.50	46	23.00	107	13.38
L. bilineata	A			13	6.50	33	16.50	46	5.75
A. acipenserinus	A			6	3.00	24	12.00	30	3.75
C. h. pallasi	A	1	.25			3	1.50	4	.50
P stellatus*	A					4	2.00	4	.50
L. armatus	A			2	1.00	1	.50	3	.38
M. polyacanthocephalus	'A	2	.50	1	.50			3	.38
S. ma lma	A	2	.50					2	.25
G. macrocephalus	A	2	.50					2	.25
H. hemilepidotus	A					2	1.00	2	.25

Appendix Table 17. Cumulative trammel net catches of all species from two regions of Ugak Bay, Cruise 3

CPUE values are mean catches per unit of effort, cumulative catch/ number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L larvae, J = juveniles, A = adults)

Species	Life history stages	Inner (1 haul) No.	Inner (1 haul) CPUE	Outer (2 haul) No.	Outer (2 haul) CPUE	Total (3 hauls) No.	Total (3 hauls) CPUE
H. octogrammus	A	66	66.00	58	29,00	124	41.33
H. lagocephalus	A	10	10.00	65	32.50	75	25.00
L. bilineata	A	8	8.00	14	7.00	22	7.33
C. h. pallasi	A			21	10.50	21	7.00
A. acipenserinus	A	1	1.00	19	9.50	20	6.67
H. stelleri	A	7	7.00	5	2.50	12	4.00
L. aspera	A	4	4.00			4	1.33
G. macrocephalus	A			2	1.00	2	.67
P. stellatus	A			2	1.00	2	.67
L. armatus	A			1	.50	1	.33
M. polyacantho-cephalus	A	1	1.00			1	.33

Appendix Table 18. Cumulative trammel net catches of all species from three regions of Ugak Bay, Cruise 4

CPUE values are mean catches per unit of effort, cumulative catch/ number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Inner (1 haul)		Middle (1 haul)		Outer (2 hauls)		Total (4 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE	No.	CPUE
H. lagocephalus	A	14	14.00	13	13.00	43	21.50	70	17.50
H. octogrammus	A	18	18.00	9	9.00	8	4.00	35	8.75
H. stelleri	A	4	4.00	11	11.00	15	7.50	30	7.50
A. acipenserinus	A	1	1.00	5	5.00	22	11.00	28	7.00
L. bilineata	A,J			13	13.00	15	7.50	28	7.00
C. h. pallasi	A					19	9.50	19	4.75
G. macrocephalus	A	1	1.00	10	10.00			11	2.75
H. decagrammus	A					4	2.00	4	1.00
M. polyacanthocephalus	A					3	1.50	3	.75
S. malma	A	1	1.00			1	.50	2	.50
L. armatus	A			1	1.00	1	.50	2	.50
O. keta	A	1	1.00					1	.25
E. diceraus	A	1	1.00					1	.25
M. scorpius	A					1	.50	1	.25
L. aspera	A	1	1.00					1	.25
P. stellatus	A					1	.50	1	.25

Appendix Table 19. Cumulative tow-net catches of all species from two regions of Kaiugnak Bay, Cruise 2

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L=larvae, J=juveniles, A=adults)

Species	Life history stages	Inner (4 hauls) No.	Inner (4 hauls) CPUE	Outer (6 hauls) No.	Outer (6 hauls) CPUE	Total (10 hauls) No.	Total (10 hauls) CPUE
M. villosus	J	3500	875.00	2033	338.83	5533	553.30
A. hexapterus	L			250	41.67	250	25.00
Hexagrammos spp.	J	12	3.00	10	1.67	22	2.20
Unid. Stichaeidae	L	4	1.00			4	.40
Unid. Bathymaster-idae	L			2	.33	2	.20
O. gorbuscha	J	1	.25	1			.20
H. jordani	J	1	.25	1			.20
Unid. Cottidae	J			1			.10
M. polyacantho-cephalus		1	.25			1	.10

Appendix Table 20. Cumulative tow-net catches of all species from two regions of Kaiugnak Bay, Cruise 3

CPUE values are mean catches per unit of effort, cumulative catch/ number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Inner (4 hauls)		Outer (6 hauls)		Total (10 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE
M. villosus	J,A			4943	823.83	4943	494.30
T. trichodon	J'	291	72.75	25	4.17	316	31.60
O. gorbuscha	J,A	2	.50	3	.50	5	.50
O. nerka	post-smelt			4	.67	4	.40
Hexagrammos spp.	J	1	.25	3	.50	4	.40
A. hexapterus	J			4	.67	4	.40
O. kisutch	post-smelt			3	.50	3	.30
T. chalcogramma	J			3	.50	3	.30
B. cirrhosus	J			2	.33	2	.20
G. aculeatus	J			1	.17	1	.10
P. paradoxus	J			1	.17	1	.10
L. bilineata	J	1	.25			1	.10

Appendix Table 21. Cumulative tow-net catches of all species from two regions of Kaiugnak Bay, Cruise 4

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Inner (4 hauls)		Outer (6 hauls)		Total (10 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE
T. trichodon	J	341	85.25	12	2.00	353	35.30
M. villosus	J	15	3.75	125	20.83	140	14.00
O. gorbuscha	J	2	.50	2	.33	4	.40
Z. silenus	J			3	.50	3	.30
G. aculeatus	J			2	.33	2	.20
H. elassodon	J	1	.25	1	.17	2	.20
T. chalcogramma	J	1	.25			1	.10
S. melanops	J			1	.17	1	.10

Appendix Table 22. Cumulative surface-trawl catches of all species from two regions of Kaiugnak Bay, Cruise 1

CPUE values are mean catches per unit of effort. cumulative catch/ number of hauls. Life history-stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Inner (2 hauls)		Outer (3 hauls)		Total (5 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE
A. hexapterus	L,J,A	511	255.50	47	15.67	558	111.60
Unid. Bathymasteridae	L	1	.50	1	.33	2	.40
Unid. Stichaeidae	L	1	.50			1	.20

Appendix Table 23. 'Cumulative midwater trawl catches of all species from two regions of Kaiugnak Bay, Cruise 1

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Inner (2 hauls)		Outer (3 hauls]		Total (5 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE
A. hexapterus	A,J	79	39.50	8	2.67	87	17.40
Unid. Bathymasteridae	L	1	.50	4	1.33	5	1.00
H, jordani	J	2	1.00	1	.33	3	.60
M. villosus	J			2	.67	2	.40
L. sagitta	L			1	.33	1	.20

Appendix Table 24. Cumulative midwater trawl catches of all species from two regions of Kaiugnak Bay, Cruise 3

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Inner (3 hauls		Outer (4 hauls)		Total (7 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE
M. villosus	J ,A			421	105.25	421	60.14
T. trichodon	J	2	.67	5	1.25	7	1.00
T. *chalcogramma*	J	1	.33	3	.75	4	.57
A. orientalism	J			2	.50	2	.29
Unidentified Cottidae	J			1	.25	1	.14
H. bolini	J			1	.25	1	.14

Appendix Table 25. Cumulative midwater trawl catches of all species from two regions of Kaiugnak Bay, Cruise 4

CPUE values are mean catches-per unit of effort, cumulative catch/ number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Inner (3 hauls)		Outer (4 hauls)		Total (7 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE
M. villosus	J			1742	435.50	1742	248.86
T. trichodon	J	26	8.67	721	180.25	747	106.71
T. chalcogramma	J	2	.67	16	4.00	18	2.57

Appendix Table 26. Cumulative beach seine catches of all species from two regions of Kaiugnak Bay, Cruise 1

CPUE values are mean catches per unit of effort, cumulative catch/ number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Inner (4 hauls)		Outer (5 hauls)		Total (9 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE
A. hexapterus	A	1242	310.50			1242	138.00
O. gorbuscha	J	3	.75	437	87.4	440	48.89
M. villosus	A	74	18.50			74	8.22
M. polyacanthocephalus	J,A	71	17.75	3	.60	74	8.22
Myoxocephalus spp.	J	61	15.25	4	.80	65	7.22
H. octogrammus	A			39	7.80	39	4.33
Unidentified Osteichthyes	L	1	.25	12	2.40	13	1.44
B. cirrhosus	J	1	.25	9	1.80	10	1.11
S. malma	A	1	.25	7	1.40	8	.89
L. sagitta		3	.75			3	.33
C. h. pallasi	J	1	.25			1	.11
G. aculeatus		1	.25			1	.11
Unidentified Scorpaeniformes	L			1	.20	1	.11
A. purpurescens	A			1	.20	1	.11
L. bilineata	A	1	.25			1	.11

Appendix Table 27. Cumulative beach seine catches of all species from two regions of Kaiugnak Bay, Cruise 2

CPUE values are mean catches per unit of effort, cumulative catch/ number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Inner (3 hauls)		Outer (3 hauls)		Total (6 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE
O. gorbuscha	J	10	3.33	2983	994.33	2993	498.83
T. trichodon	J			315	105.00	315	52.50
M. polyacanthocephalus	J,A	236	78.67	3	1.00	239	39.83
H. octogrammus				65	21.67	65	10.83
Hexagrammos spp.	J	19	6.33			19	3.17
O. keta	J	14	4.67			14	2.33
A. hexapterus	A	7	2.33			7	1.17
L. bilineata	A	1	.33	3	1.00	4	,67
Unidentified Cottidae	J			2	.67	2	.33
P. barbata	J,A	1	.33	1	.33	2	.33
S. malma	A			1	.33	1	.17
A. acipenserinus	A			1	.33	1	.17
P. laeta	A			1	.33	1	.17

Appendix Table 28. Cumulative beach seine catches of all species from two regions of Kaiugnak Bay, Cruise 3

CPUE values are mean catches per unit of effort, cumulative catch/ number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Inner (4 hauls) No.	Inner (4 hauls) CPUE	Outer (3 hauls) No.	Outer (3 hauls) CPUE	Total (7 hauls) No.	Total (7 hauls) CPUE
T. *trichodon*	J			2205	735.00	2205	315.00
A. *hexapterus*	A	1373	343.25			1373	196.1.4
G. *aculeatus*	J,A	1	.25	419	139.67	420	60.00
O. *gorbuscha*	A,J	94	23.50	32	10.67	126	18.00
H. *octogrammus*	J,A	6	1.50	76	25.33	82	11.71
B. *cirrhosus*	J	1	.25	46	15.33	47	6.71
H. *stelleri*	J	15	3.75	17	5.67	32	4.57
P. *barbata*	J			14	4.67	14	2.00
O. *keta*	J	11	2.75	2	.67	13	1.86
P. *laeta*	A			9	3.00	9	1.29
M. *polyacanthocephalus*	J	5	1.25	2	.67	7	1.00
L. *bilineata*	J	7	1.75			7	1.00
S. *malma*	A			4	1.33	4	.57
H. *lagocephalus*	A			4	1.33	4	.57
L. *sagitta*	A			2	.67	2	.29
P. *stellatus*	A			1	.33	1	.14

Appendix Table 29. Cumulative beach seine catches of all species from two regions of Kaiugnak Bay, Cruise 4

CPUE values are mean catches per unit of effort-, cumulative catch/ number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Inner (5 hauls)		Outer (4 hauls)		Total (9 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE
A. hexapterus	A,J	3067	61.3.40	125	31.25	3192	354.67
H. octogrammus	J,A	23	4.60	85	21.25	108	12.00
B. cirrhosus	J			28	7.00	28	3.11
M. polyacanthocephalus	J,A	21	4.20	5	1.25	26	2.89
H. lagocephalus	J,A	23	4.60	1	.25	24	2.67
H. stelleri	J,A	11	2.20	12	3.00	23	2.56
P. barbata	A	3	.60	9	2.25	12	1.33
P. laeta	A			11	2.75	11	1.22
M. scorpius	A,J			4	1.00	4	. 4 4
P. stellatus	J	4	.80			4	.44
L. bilineata	A	2	.40			2	.22
S. malma	A	1	.20			1	.11
Unidentified Cottidae	J	1	.20			1	.11

Appendix Table 30. Cumulative try net catches of all species from two regions of Kaiugnak Bay, Cruise 2

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Inner (3 hauls) No.	Inner (3 hauls) CPUE	Outer (6 hauls) No.	Outer (6 hauls) CPUE	Total (9 hauls) No.	Total (9 hauls) CPUE
L. sagitta	J,A			128	21.33	128	14.22
L. bilineata	J			58	9.67	58	6.44
L. aspera	J			29	4.83	29	3.22
Gymnocanthus spp.	J,A	2	.66	17	2.83	19	2.11
H. lagocephalus	A			7	1.17	7	.78
P. melanostictus	J,A			6	1.00	6	.67
H. octogrammus	J,A	4	1.33			4	.44
Triglops sp. (probably *T. pingeli)*				2	.33	2	.22
H. stelleri	A			1	.17	1	.11
H. hemilepidotus	A			1	.17	1	.11
I. isolepis	A			1	.17	1	.11
P. stellatus	A			1	.17	1	.11
M. polyacanthocephalus	A			1	.17	1	.11

Appendix Table 31. Cumulative try net catches of all species from two regions of Kaiugnak Bay, Cruise 3

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Inner (3 hauls)		Outer (5 hauls)		Total (8 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE
L. sagitta	J			181	36.20	181	27.63
L. bilineata	J,A	1	.33	84	16.80	85	10.63
B. cirrhosus	J			33	6.60	33	4.13
H. octogrammus	A,J	11	3.67	14	2.80	25	3.13
L. aspera	J	2	.67	21	4.20	23	2.88
H. lagocephalus	A,J	2	.67	20	4.00	22	2.75
H. stelleri	J	3	1.00	6	1.20	9	1.13
Gymnocanthus spp.	A			9	1.80	9	1.13
T. *chalcogramma*	J			6	1.20	6	.75
H, jordani	A	3	1.00			3	.38
P. stellatus	J			3	.60	3	.38
I. isolepis	J			2	.40	2	.25
M. jaok	A	1	.33			1	.13
P. barbata	J			1	.20	1	.13
Apedichthys flavidus	A			1	.20	1	.13
H. stenolepis	J			1	.20	1	.13

Appendix Table 32. Cumulative try net catches of all species from two regions of Kaiugnak Bay, Cruise 4

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Inner (3 hauls)		Outer (9 hauls)		Total (12 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE
L. bilineata	J,A	2	.67	77	8.56	79	6.58
H. octogrammus	J,A	24	8.00	20	2.22	44	3.67
H. lagocephalus	A,J			40	4.44	40	3.33
H. stelleri	J,A	10	3.33	26	2.89	36	3.00
B. cirrhosus	J	10	3.33	22	2.44	32	2.67
L. aspera	J	6	2.00	1	.11	7	.58
Gymnocanthus spp.	J,A	2	.67	4	.44	6	.50
P. melanostictus	J,A			6	.67	6	.50
M. polyacanthocephalus	A,J	1	.33	4	.44	5	.42
P. stellatus	A	3	1.00	1	.11	4	.30
H. jordani	J	2	.67	1	.11	3	.25
P. barbata	J			3	.33	3	.25
I. isolepis	J			3	.33	3	.25
L. sagitta	J			2	.22	2	.17
Aulorhynchus flavidus	J			1	.11	1	.08
H. decagrammus	A			1	.11	1	.08
H. hemilepidotus	A			1	.11	1	.08
M. scorpius	A			1	.11	1	.08
S. gilli	A			1	.11	1	.08
A. acipenserinus	A			1	.11	1	.08
S. punctatus	A	1	.33			1	.08
H. elassodon	J	1	.33			1	.08
H. stenolepis	J			1	.11	1	.08

Appendix Table 33. Cumulative trammel net catches of all species from Kaiugnak Bay, Cruise 2 (2 standard hauls were made in Inner Region only)

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls, Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Inner (2 hauls) No.	Inner (2 hauls) CPUE
H. octogrammus	A	65	32.50
H. lagocephalus	A	35	17.50
H. stelleri	A	1	.50
B. caeruleofasciatus	A	1	.50
L. bilineata	A	1	.50

Appendix Table 38. [illegible]
Kaiugnak Bay, Cruise 3

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Inner (1 haul)		Outer (1 haul)		Total (2 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE
H. lagocephalus	A	62	62.00	47	47.00	109	54.50
H. octogrammus	A	94	94.00	15	15.00	109	54.50
S. melanops	A			3	3.00	3	1.50
H. stelleri	A	1	1.00	1	1.00	2	1.00
L. bilineata	A	1	1.00	1	1.00	2	1.00
Myoxocephalus sp.	A			1	1.00	1	.50
M. polyacanthocephalus	A	1	1.00			1	.50
A. acipenserinus	A	1	1.00			1	.50
B. caeruleofasciatus	A			1	1.00	1	.50

Appendix Table 35. Cumulative trammel net catches of all species from two regions of Kaiugnak Bay, Cruise 4

CPUE values are mean catches per unit of effort, cumulative catch/ number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Inner (2 hauls)		Outer (1 haul)		Total (3 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE
H. lagocephalus	A	15	7.50	46	46.00	61	2(3.33
H. octogrammus	A	12	6.00			12	4.00
H. stelleri	A	5	2.50	1	1.00	6	2.00
S. melanops	A			1	1.00	1	.33
H. decagrammus	A			1	1.00	1	.33
M. polyacanthocephalus	A	1	.50			1	.33
L. bilineata	A	1	.50			1	.33

Appendix Table 36. Cumulative tow net catches of all species from five regions of Alitak Bay, Cruise 2

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L=larvae, J=juveniles, A=adults)

Species	Life history stages	Deadman (10 hauls) No.	Deadman (10 hauls) CPUE	Hepburn (5 hauls) No.	Hepburn (5 hauls) CPUE	Westside (4 hauls) No.	Westside (4 hauls) CPUE	Middle (4 hauls) No.	Middle (4 hauls) CPUE	Outer (3 hauls) No.	Outer (3 hauls) CPUE	Total (26 hauls) No.	Total (26 hauls) CPUE
O. gorbuscha	J	806	80.60	825	165.00	20	5.00	1	.25	2	.67	1654	63.62
Hexagrammos spp.	J	61	6.10	52	10.40	101	25.25	20	5.00	472	157.33	706	27.15
Unid. Bathymasteridae	L									25	8.33	25	.96
A. hexapterus	L									25	8.33	25	.96
O. keta	J			5	1.00							5	.19
S. malma	A	5	.50									5	.19
H. jordani	J	1	.10			1	.25	1	.25	1	.33	4	.15
O. kisutch	post-smolt	3	.30									3	.12
O. nerka	post-molt	2	.20									2	.08

Appendix Table 37. Cumulative tow net catches of all species from five regions of Alitak Bay, Cruise 3

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L=larvae, J=juveniles, A=adults)

Species	Life history stages	Deadman (10 hauls)		Hepburn (5 hauls)		Westside (4 hauls)		Middle (4 hauls)		Outer (6 hauls)		Total (29 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE	No.	CPUE	No.	CPUE	No.	CPUE
O. *gorbuscha*	J	565	56.50	1304	260.80	58	14.50	10	2.5			1937	66.79
Hexagrammos spp.	J	1	.10	2	.40	54	13.50					57	1.97
G. *aculeatus*	J,A					24	6.00					24	.83
O. keta	J	5	.50			2	.50					7	.24
C. h. pallasi	J					1	.25					1	.03
O. nerka	post-smelt	1	.10									1	.03
S. *malma*	A					1	.25					1	.03
M. villosus	A					1	.25					1	.03
B. cirrhosus	J	1	.10									1	.03
Z. silenus	J							1	.25			1	.03

Appendix Table ,38. **Cumulative tow net catches of all species from five regions of Alitak Bay, Cruise 4**

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L=larvae, J=juveniles, A=adults)

Species	Life history stages	Deadman (10 hauls)		Hepburn (12 hauls)		Westside (3 hauls)		Middle (5 hauls)		Outer (6 hauls)		Total. (36 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE	No.	CPUE	No.	CPUE	No.	CPUE
M. *villosus*	L,J	2.	.20	6697	558.08			1	.20			6700	186.11
G. *aculeatus*	J,A	1	.10	11	.92			2	.40	3	.50	17	.47
O. gorbuscha	J	4	.40	3	.25	1	.33					8	.22
S. *melanops*	J							1	.20	1	.33	2	.06
O. *kisutch*	post-smelt			1	.08							1	.03
G. *macrocephalus*	J			1	.08							1	.03
S. nigrocinctus	J									1	.33	1	.03
H. lagocephalus	J							1	.20			1	'03
O. elongatus	J							1	.20			1	.03
B. bilobus	A					1	.33					1	.03
H. jordani	J			1	.08							1	.03
P. barbata	A			1	.08							1	.03
A. hexapterus	A							1	.20			1	.03

Appendix Table 39. Cumulative surface trawl catches of all species from two regions of Alitak Bay, Cruise 1

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L=larvae, J=juveniles, A=adults).

Species	Life history stages	Deadman (7 hauls)		Hepburn (3 hauls)		Total (10 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE
O. gorbuscha	J	1	.14			1	.10
O. keta	J	1	.14			1	.10

Appendix Table 40. Cumulative midwater trawl catches of all species from four regions of Alitak Bay, Cruise 1

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Deadman (5 hauls) No.	Deadman (5 hauls) CPUE	Hepburn (3 hauls) No.	Hepburn (3 hauls) CPUE	Middle (2 hauls) No.	Middle (2 hauls) CPUE	Outer (3 hauls) No.	Outer (3 hauls) CPUE	Total (13 hauls) No.	Total (13 hauls) CPUE
M. villosus	A,L	5680	1136.00	193	64.33	1250	625.00	60	20.00	7183	552.54
Hexagrammos spp.	J			2	.67			1	.33	3	.23
B. pusillum	A	2	,40							2	.15
A. hexapterus	A					2	1.00			2	.15
Unid. Bathymasteridae	L							2	.67	2	.15
O. *gorbuscha*	J			1	.33					1	.08
T. chalcogramma	A							1	.33	1	.08
L. sagitta	J					1	.50			1	.08
Myoxocephalus sp.	A					1	.50			1	.08

Appendix Table 41. Cumulative midwater trawl catches of all species from four regions of Alitak Bay, Cruise 3

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Deadman (6 hauls)		Hepburn (4 hauls)		Middle (6 hauls)		Outer (5 hauls)		Total (21 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE	No.	CPUE	No.	CPUE
M. villosus	J,A	332	55.33	21602	?400.50	5786	964.33	2823	565.80	30549	1454.71
O. gorbuscha	J					74	12.33			74	3.52
B. pusillum	A	53	8.83							53	2,52
Lumpenus sp. (probably *L. medius*)	L	8	1.33							8	.38
O. keta	J					5	.83			5	.24
T. trichodon	A					2	.33	1	.2	3	.14
C. h. pallasi	A					1	.17			1	.05
B. cirrhosus	J			1	.25					1	.05
L. aspera	A	1	.17							1	.05

Appendix Table 42. Cumulative midwater trawl catches of all species from four regions of Alitak Bay, Cruise 4

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance
(L = larvae, J = juveniles, A = adults)

Species	Life history stages	Deadman (6 hauls)		Hepburn (3 hauls)		Middle (4 hauls)		Outer (5 hauls)		Total (18 hauls)	
		No.	CPUE	SO.	CPUE	No.	CPUE	No.	CPUE	No.	CPUE
M. villosus	J,A	5688	948.00	754	251.33	217	54.25	162	32.40	6821	378.94
Lumpenus sp. (probably *L. medius*)	J	424	70.67	225	75.00					649	36.06
L. medius	L					72	18.00	100	20.00	172	9.56
C. h. pallasi	A							128	25.60	128	7.11
T. trichodon	J,A					1	.25	121	24,20	122	6.78
A. hexapterus	J,A							64	12.80	64	3.56
B. pusillum	A	32	5.33							32	1.78
T. chalcogramma	J							2	.40	2	.11
Z. silenus	J							2	.40	2	.11
H. stelleri	J							1	.20	1	.06
B. bilobus	A							1	.20	1	.06
H. jordani	A							1	.20	1	.06
A. ventricosus	A	1	.17							1	.06

Appendix Table 43. Cumulative beach seine catches of all species from two regions of Alitak Bay, Cruise 1

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Deadman (6 hauls) No.	Deadman (6 hauls) CPUE	Westside (2 hauls) No.	Westside (2 hauls) CPUE	Total (8 hauls) No.	Total (8 hauls) CPUE
O. keta	J	778	129.67			778	97.25
O. gorbuscha	J	137	22.83			137	17.13
H. octogrammus	A	13	2.17	5	2.50	18	2.25
S, malma	A	15	2.50	1	.50	16	2.00
G. macrocephalus	J	14	2.33			14	1.75
Myoxocephalus spp.	J	2	.33	11	5.50	13	1.63
M. polyacanthocephalus	J,A	7	1.17	2	1.00	9	1.13
T. chalcogramma	A,J	7	1.17			7	.88
C. h. pallasi	A	2	.33			2	.25
M. villosus	A	2	.33			2	.25
L. sagitta	A	2	.33			2	.25
G. aculeatus	A	1	.17			1	.13
H. stelleri	A	1	.17			1	.13
P. stellatus	A			1	.50	1	.13

Appendix Table 44. Cumulative beach seine catches of all species from four regions of Alitak Bay, Cruise 2

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L . larvae, J = juveniles, A = adults)

Species	Life history stages	Deadman (4 hauls)		Eastside (4 hauls)		Westside (4 hauls)		Tannerhead (2 hauls)		Total (14 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE	No.	CPUE	No.	CPUE
A. hexapterus	A	147	36.75	2	.50					149	10.54
O. gorbuscha	J			6	1.50	1	.25	74	37.00	81	5.79
M. polyacanthocephalus	J	25	6.25	3	.75	14	3.50			42	3.09
F. stellatus	A	2	,50	6	1.50	10	2.50	17	8.50	35	2.50
O. keta	J	14	3.50	5	1.25	4	1.00	8	4.00	31	2.21
S. malma	A	5	1.25	4	1.00	22	5.50			31	2.21
H. octogrammus	J,A	19	4.75	2	.50	9	2.25			30	2.14
O. kisutch	J	18	4.50			4	1.00			22	1.57
?. laeta	A,J	3	.75	1	.25	9	2.25	1	.50	14	1.00
L. bilineata	J			7	1.75			7	3.50	14	1.00
L. armatus	A	3	.75	1	.25	4	1.00	2	1.00	10	.71
G. macrocephalus		9	2.25							9	. 6 4
M. scorpius	A					4	1.00			4	.29
B. cirrhosus	A	3	.75							3	.21
Hexagrammos spp.	J					2	.50			2	.14
H. lagocephalus	J	2	,50							2	.14
O. nerka	post-molt			1	.25					1	.07
L. aspera	A					1	.25			1	.07
P. melanostictus								1	.50	1	.07

Appendix Table 45. *Cumulative* beach seine catches of all species from four regions of Alitak Bay, Cruise 3

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance
(L = larvae, J = juveniles, A = adults)

Species	Life history stages	Deadman (6 hauls)		Eastside (4 hauls)		Westside (4 hauls)		Tannerhead (2 hauls)		Total (16 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE	No.	CPUE	No.	CPUE
A. hexapterus	J,A	276	46.00	150	37.50	1790	447.50			2216	138,50
O. gorbuscha	A	234	47.33							284	17.75
H. stelleri	J,A	122	20.33	9	2.25	120	30.09			251	15.69
H. octogrammus	J,A	125	20.83	5	1.25	38	9.50			168	10.50
S. malma	A	31	5.17	38	9.50	1	.25	2	1.00	72	4.50
L. bilineata	J,A			26	6.50			17	8.50	43	2.69
M. polyacanthocephalus	J,A	13	2.17	18	4.50	11	2.75			42	2.63
P. laeta	A,J	5	.83			15	3.75			20	1,25
Gymnocanthus spp.	J,A			14	3.50	1	.25	1	.50	16	1.00
B. cirrhosus	A,J	6	1.00	1	.25	8	2.00			15	.94
A. fenestralis	J,A			9	2.25	3	.75			12	.75
G. aculeatus	J					9	2.25			9	.56
P. barbata	J,A	4	.67	3	.75					7	.44
L. armatus	A			4	1.00	1	.25	1	.50	6	.38
H. jordani	J,A	4	.67							4	.25
M. scorpius	A,J	1	.17			3	.75			4	.25
P. stellatus	A,J					1	.25	2	1.00	3	.19
L. sagitta	A			1	.25					1	.06

Appendix Table 46. Cumulative beach seine catches of all species from four regions of Alitak Bay, *Cruise* 4

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Deadman (7 hauls)		Eastside (5 hauls)		Westside (6 hauls)		Tannerhead (3 hauls)		Total (21 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE	No.	CPUE	No.	CPUE
A. hexapterus	J,A	6312	901.71	20008	4001.60	77	12.83	18	6.00	26415	1257.86
H. stelleri	J	74	10.57	8	1.60	127	21.17			209	9.95
H. octogrammus	J,A	95	13.57	1	.20	67	11.17			163	7,76
C. h. pallasi	L	2	.29	108	21.60					110	5.24
M. polyacanthocephalus	J,A	25	3.57			37	6.17	1	.33	63	3.00
L. bilineata	J,A	1	.14	27	5.40	2	.33	28	9.33	58	2.76
S. malma	A	29	4.14							29	1.38
Gymnocanthus spp.	J			17	3.40	2	.33	5	1.67	24	1.14
L. armatus	A,J					2	.33	13	4.33	15	.71
O. gorbuscha	A,J	4	.57			10	1.67			14	.67
P. stellatus	J,A					2	.33	12	4.00	14	.67
O. kisutch	post-molt, A	11	1.57	1	.20					12	.57
M. scorpius	A,J	1	.14			11	1.83			12	.57
P. barbata	J	2	.29			5	.83	1	.33	8	.38
P. laeta	A	2	.29			6	1.00			8	.38
B. cirrhosus	J	1	.14			5	.83	1	.33	7	.33
P. melanostictus	J							7	2.33	7	.33
T. trichodon	J							6	2.00	6	.29
H. jordani	J,A	3	.43			2	.33			5	.24
A. fenestralis	J					3	.50			3	.14
S. melanops	J					1	.17			1	.05
H. lagocephalus	J					1	.17			1	.05
L. sagitta	A	1	.14							1	.05

Appendix Table 47. Cumulative try net catches of all species from three regions of Alitak Bay, Cruise 2

CPUE values are mean catches per unit of effort, cumulative catch/ number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Eastside (7 hauls)		Westside (6 hauls)		Tannerhead (8 hauls)		Total (21 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE	No.	CPUE
L. bilineata	J,A					71	8.88	71	3.38
H. octogrammus	A	8	1.14	4	.67			12	.57
H. stelleri	A			2	.33	6	.75	8	.38
L. sagitta	A,J					6	.75	6	.29
L. aspera	J					4	.50	4	.19
P. melanostictus	J,A					4	.50	4	.19
S. melanops	J	2	.29	1	.17			3	.14
G. macrocephalus	J			2	.33			2	.10
Gymnocanthus spp.	J					2	.25	2	.10
P. laeta	A	2	.29					2	.10
T. chalcogramma	A			1	.17			1	.05
H. lagocephalus	A					1	.13	1	.05
B. bilobus	A			1	.17			1	.05
H. hemilepidotus	A	1	.14					1	.05
Triglops sp. (probably *T. pingeli*)	J					1	.13	1	.05
Unidentified Stichaeidae	J					1	.13	1	.05
S. *punctatus*		1	.14					1	.05
H. stenolepis	J					1	.13	1	.05

Appendix Table 48. Cumulative try net catches of all species from three regions of Alitak Bay, Cruise 3

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Eastside (8 hauls) No.	Eastside (8 hauls) CPUE	Westside (5 hauls) No.	Westside (5 hauls) CPUE	Tannerhead (6 hauls) No.	Tannerhead (6 hauls) CPUE	Total (19 hauls) No.	Total (19 hauls) CPUE
L. bilineata	J	3	.38	1	.20	148	24.67	152	8.00
H. octogrammus	A,J	42	5.25	12	2.40	2	.33	56	2.95
H. stelleri	J,A	3	.38	1	.20	11	1.83	15	.79
Gymnocanthus spp.	J,A			1	.20	8	1.33	9	.47
H. jordani	A,J	2	.25	3	.60	2	.33	7	.37
H. lagocephalus	A	3	.38	1	.20			4	.21
G. macrocephalus	J	1	.13			2	.33	3	.16
H. stenolepis	J					3	,50	3	.16
P. melanostictus	A					3	.50	3	.16
M. scorpius	A	1	.13	1	.20			2	.11
M. polyacantho-cephalus	J	1	.13					1	.05
N. pribilovius	J	1	.13					1	.05
L. cyclopus	J			1	.20			1	.05
L. sagitta	J					1	.17	1	.05
P. laeta	A	1	.13					1	.05
L. aspera	J					1	.17	1	.05
P. stellatus	J					1	.17	1	.05

Appendix Table 49. Cumulative try net catches of all species from three regions of Alitak Bay, Cruise 4

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Eastside (8 hauls) No.	Eastside (8 hauls) CPUE	Westside (7 hauls) No.	Westside (7 hauls) CPUE	Tannerhead (6 hauls) No.	Tannerhead (6 hauls) CPUE	Total (21 hauls) No.	Total (21 hauls) CPUE
A. hexapterus	A,J	948	118.50			3	.50	951	45.29
L. bilineata	J,A			6	.86	221	36.83	227	10.81
H. octogrammus	J,A	99	12.38	8	1.00			107	5.10
H. stelleri	J,A	7	.88	47	6.71	28	4.67	82	3.90
L. aspera	J,A	1	.13	55	7.86	6	1.00	62	2.95
H. stenolepis	J					51	8.50	51	2.43
Gymnocanthus spp.	J,A	2	.25	19	2.71	21	3.50	42	2.00
A. acipenserinus	J					17	2.83	17	.81
H. jordani	J,A	2	.25	8	1.14	4	.67	14	.67
Unidentified Pleuronectidae	J					12	2.00	12	.57
B. cirrhosus	J	5	.63			1	.17	6	.29
P. melanostictus	A,J					6	1.00	6	.29
M. polyacanthocephalus	J,A	3	.3a	1	.14	1	.17	5	.24
H. lagocephalus	A	4	.50					4	.19
M. scorpius	J,A	1	.13	3	.43			4	.19
P. barbata	J	2	.25			2	.33	4	.19
T. chalcogramma	J					3	.50	3	.14
1'. *pingeli*		3	.38					3	.14
S. *punctatus*	A	3	.38					3	.14
P. stellatus	A	3	.38					3	.14
G. macrocephalus	J	1	.13			1	,17	2	.10
P. laeta	A			2	.29			2	.10
s. melanops	J	1	.13					1	.05
O. elongatus	J					1	.17	1	.05
B. bilobus	A	1	.13					1	.05
E. diceraus	J	1	.13					1	.05
M. jack	J			1	.14			1	.05

Appendix Table 50. Cumulative trammel net catches of all species from three regions of Alitak Bay, Cruise 2

CPUE values are mean catches per unit of effort, cumulative catch/ number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Deadman (2 hauls)		Eastside (1 haul)		Westside (3 hauls)		Total (6 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE	No.	CPUE
H. octogrammus	A	104	52.00	66	66.00	247	82.33	417	69.50
H. stelleri	A	14	7.00			11	3.67	25	4.17
M. scorpius	A	1	.50			8	2.67	9	1.50
H. lagocephalus	A			7	7.00			7	1.17
L. aspera	A	1	.50			6	2.00	7	1.17
O. nerka	A					5	1.67	5	.83
C. h. pallasi	A					4	1.33	4	.67
L. bilineata	A			1	1.00	3	1.00	4	.67
P. stellatus	A					4	1.33	4	.67
S. malma	A					3	1.00	3	.50
M. polyacanthocephalus	A	1	.50	1	1.00	1	.33	3	.50
L. armatus	A					2	.67	2	.33
O. keta	A					1	.33	1	.17
H. stenolepis	A	1	.50					1	.17

Appendix Table 51. Cumulative trammel net catches of all species from three regions of Alitak Bay, Cruise 3

CPUE values are mean catches per unit of effort, cumulative catch/ number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Deadman (1 haul)		Eastside (1 haul)		Westside (2 hauls)		Total (4 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE	No	CPUE
H. octogrammus	A	146	146.00	194	194.00	131	65.50	471	117.75
H. lagocephalus	A			18	18.00			18	4.50
H. stelleri	A	11	11.00			3	1.50	14	3.50
M. scorpius	A					7	3.50	7	1.75
S. ma lma	A	2	2.00	1	1.00	4	2.00	7	1.75
L. aspera	A	3	3.00					3	.75
G. macrocephalus	A			1	1.00			1	.25
L. armatus	A					1	.50	1	.25
M. polyacantho-cephalus		1	1.00					1	.25
P. stellatus	A					1	.50	1	.25

Appendix Table 52. Cumulative trammel net catches of all species from three regions of Alitak Bay, Cruise 4

CPUE values are mean catches per unit of effort, cumulative catch/number of hauls. Life history stages represented in the entire bay's catch are in order of decreasing relative abundance (L = larvae, J = juveniles, A = adults)

Species	Life history stages	Deadman (2 hauls)		Eastside (2 hauls)		Westside (3 hauls)		Total (7 hauls)	
		No.	CPUE	No.	CPUE	No.	CPUE	No.	CPUE
H. octogrammus	A	16	8.00	40	20.00	128	42.67	184	26.29
H. stelleri	A	31	15.50	8	4.00	20	6.67	59	8.43
H. lagocephalus	A			53	26.50	1	.33	54	7.71
G. macrocephalus	J,A	4	2.00	3	1.50	3	1.00	10	1.43
M. scorpius	A					10	3.33	10	1.43
P. stellatus	A	1	.50			2	.67	3	.43
M. polyacanthocephalus	A			1	.50	1	.33	2	,29
P. monopterygius	A	1	.50					1	.14
B. bilobus	A					1	.33	1	.14
H. jordani	A					1	.33	1	.14
C. polyactocephalus	A	1	.50					1	.14
L. aspera	A					1	.33	1	.14